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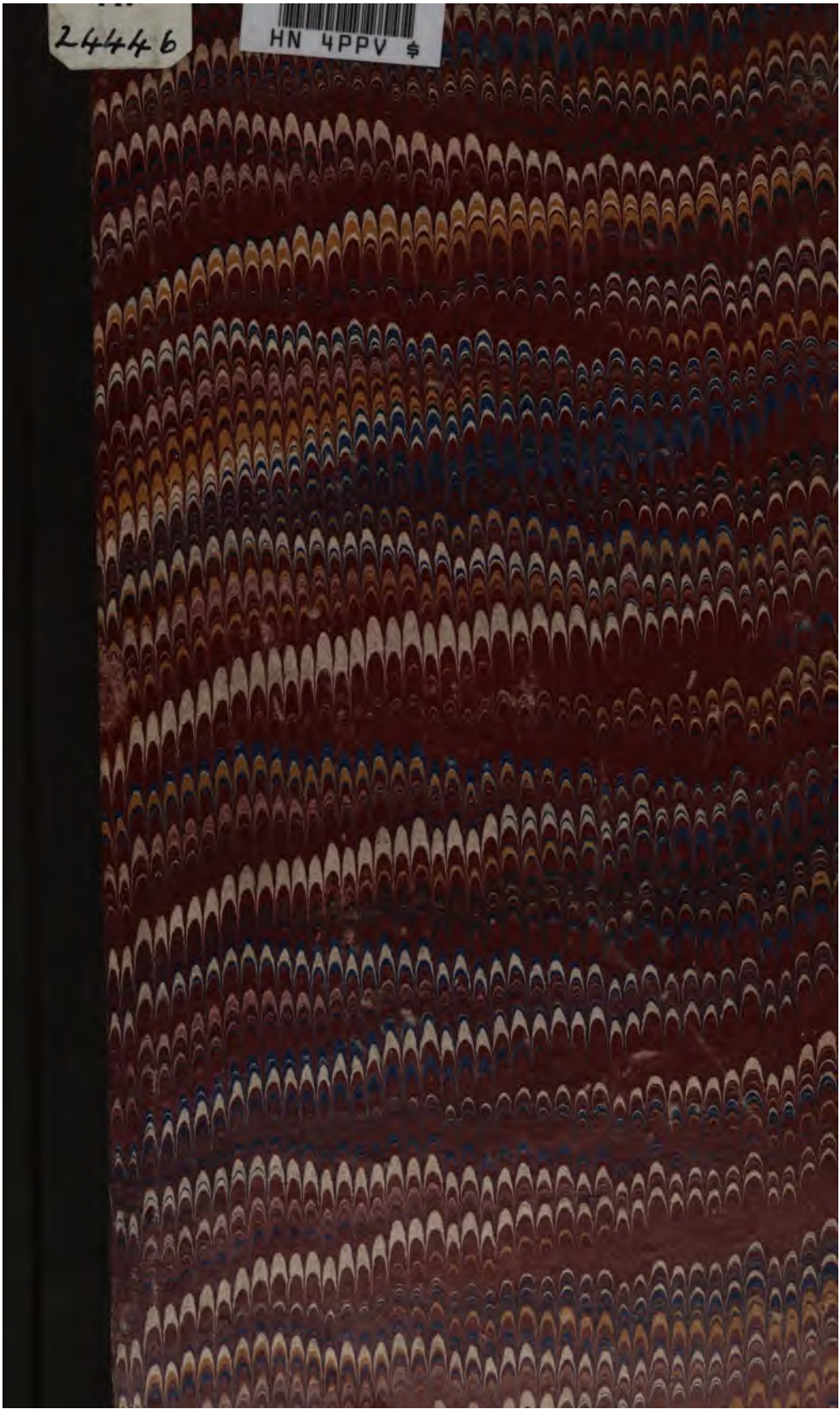

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20 Feb. 1884.

THE WAY TO AVOID

CENTRE OF OUR VIOLENT GALES.

COMPILED BY

GEO. W. BLUNT.

U. S. — BUREAU OF NAVIGATION, - Hydrog. Office
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PREFACE.

A BELIEF that much loss of life and property on the ocean might be prevented by a proper knowledge of the character of our severe gales, and how to avoid them, has induced me to prepare this work intended for those navigating the North Atlantic Ocean. It is a compilation from the labors of our countryman, Wm. C. Redfield, the discoverer of the Law of Storms (first published in 1837 in the American Coast Pilot), and now generally recognized; Col. Reid, Royal Engineers; Mr. Piddington of Calcutta; the Barometer by Admiral Fitzroy, R. N.; and the Admiralty work on Revolving Storms; with some suggestions of

GEO. W. BLUNT.

NEW YORK, *November* 1, 1866.

THE WAY TO AVOID

THE CENTRE OF OUR VIOLENT GALES.

THE SIZES OF CYCLONES—THE GENERAL PRACTICAL APPLICATION OF THE LAW OF STORMS, AS TO AVOIDING CYCLONES, PRESERVING VESSELS FROM DAMAGE WHEN INVOLVED IN THEM, AND PROFITING BY THEM WHEN THIS CAN BE SAFELY DONE—BEARING OF THE CENTRE OF CYCLONE—WIND OR CYCLONE POINTS AND COMPASS POINTS—PROBABILITY OF THE INCURVING OF WINDS AND THE FLATTENING IN OF CYCLONES ON APPROACHING THE LAND—ASCERTAINING THE TRACK OF A CYCLONE—SCUDDING OR HEAVING TO—USES OF THE TRANSPARENT HORN CARDS—SPECIAL EXAMPLES FOR THE WEST INDIES, ATLANTIC OCEAN, COASTS AND SEAS OF EUROPE.

1. THE SIZES OF CYCLONES.—We may suppose that there might be a complete chain, as to size, of Cyclones; from the water-spout, which becomes a whirlwind when it reaches the land, through the Tornado of a few tens or hundreds of yards in diameter, up to the great hurricanes of the Atlantic or Indian Ocean; and so far it is certain that we cannot on the one hand say *how small* true Cyclones may be, as we have traced them to probably less than one hundred miles in diameter,* and possibly as small as fifty† in the Indian seas. On the other hand, when we come to the smaller, Tornado-like, Cyclones below, say fifty miles in diameter, there is no good evidence, as yet, for their revolving invariably in the same direction when occurring in the same hemisphere, as the larger storms; and thus we cannot distinctly affirm that the very small Cyclones are subjected to the same laws, or arise from the same causes. This is one of those questions which require frequent and extensive observation to settle. For the sailor, however, it may suffice to say that Cyclones revolving according to the usual law, may be looked for of all sizes from fifty to five hundred, or even a thousand miles in diameter; the very large and very small ones being comparatively rare, and the small ones often sudden and severe. There is no doubt, also, that at times they both dilate and contract in their progress. We cannot certainly say, if, when they become larger, they become more or less severe, but I think that when they contract they sometimes augment fearfully their violence, approaching apparently the concentrated power of the Tornado or the Whirlwind.

2. In the West Indies the researches of Mr. Redfield and Colonel Reid seem to show that though while approaching to, or within the islands, they are sometimes as small as one hundred or one hundred and fifty miles in diameter; they may, and it would seem most frequently do, after reaching the Atlantic Ocean, dilate considerably, and there often attain to six hundred or even one thousand miles in diameter, the wind blowing an excessively severe gale over all this area, and towards its centre becoming of true hurricane violence, and the whole vortex, so whirling, travels over thousands of miles of track.

3. THE GENERAL PRACTICAL APPLICATION OF THE LAW OF STORMS.—Every sailor can understand when he looks at a waterspout or a heavy dust-whirlwind, that a canoe or a Thames wherry caught in it, however cleverly managed and well prepared, even were she fitted as a life-boat, would run awful risks; that it would be the extreme of folly to attempt to sail *through* one, and for the boat or canoe-man not to do all in his power to keep out of its way; and finally, that if the waterspouts and whirlwinds had regular veerings of winds and progressions on given tracks, which the boatman perfectly knew, he might generally keep out of the way of harm, and sometimes even profit by them. This is the seaman's own case. His finest merchantman is but "a cock boat," and the proudest line-of-battle ship "a great war canoe," which in a waterspout or whirlwind, in the shape of a hurricane or Typhoon, may be destroyed or damaged, or get through it safely, or profit by some parts of the wind if well managed; or the commander of which may in ignorance run headlong into the mischief he dreads. This is owing to the *scale* on which the operations of nature in Cyclones are performed, which is so large, that to our imperfect faculties the winds always appear—and have hitherto been considered—as blowing in straight lines. The moment they are considered as curves, and probably parts of a circle or ellipse, and that this circle or ellipse is both whirling round, and the whole moving bodily forward according to fixed laws, the matter is clear; but there is

* See Fourteenth Memoir, Journal Asiatic Soc. Bedg. Vol. XIV.

† Cyclone of the *Cashmere Merchant*, Nov. 1839, Second Memoir, Jour. As. Soc. Beng. Vol. IX.

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CENTRE OF OUR VIOLENT GALES.

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Navy Department.

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with many plain seamen great difficulty in understanding how to apply this knowledge, which I shall now try to remove: addressing myself to such as if we were sitting at the cabin table together.

4. It is clear that there are three kinds of cases for the management of your ship, in or at the approach of a Cyclone. You may avoid it altogether with sea-room and management; you may get through it safely by avoiding the dangerous centre; by heaving to on the right tack; or by running off in the proper direction; or you may even *profit* by it!

5. Let us take the first supposition—that of avoiding a Cyclone. Every seaman almost has shortened sail or altered his course, and many have hove to, to avoid a dangerous-looking waterspout. Well, this is the most usual method by which circular storms are avoided, for they are neither more nor less (for your purpose) than *wind-spouts* travelling along given tracks at certain rates, of the neighborhood of which the weather and your barometer inform you; and of the course, (*i. e.* track,) of which I shall shortly show you how to form a tolerable estimate, by the winds, your transparent Storm Cards, and your log. If that course crosses your track it is plain that you may heave to and let it pass on first. If you are on that side of it that, by standing on or standing back, for a time you increase your distance from it, or get out of its way, of course you will do so; and in both these cases you will have *avoided* a Cyclone by your knowledge of the Law of Storms.

6. But next: from your position, or for want of sea-room, or from the excessive suddenness of the approach of a Cyclone, you may be involved in one. Your business now is to get out of it as soon, and with as little damage as you can.

The dangers to a vessel *in* a Cyclone are three. The *veering* of the wind; the excessive violence of it near the centre; and the sudden calms and shifts and awful sea *at* the centre. All these involve, as you well know, damage and loss by dismasting, straining, leaks, and distress of various kinds up to foundering; and you will find in the present Chapter ample rules to show you that if involved in a Cyclone, *even with a fair wind*, you should often heave to, not to approach the centre, or with a foul one that you should, if the weather possibly admits of it, stand back: that if you have to heave to, you will, if you take the right tack, have both the veerings of the wind, and the shift of it such, that you will always "come up" to it, and run no risk of being taken aback; while if hove to on the wrong one, you will certainly have the wind heading you off, and in all probability be taken aback if it shifts. Of the dangers in all these cases every seaman is aware, as for instance that of getting stern-way* in a hurricane; and it is one, and not the least of the practical applications of our Science, that there is scarcely yet a case on record, in all the logs that have been examined, where ships which have suffered in a Cyclone might not have escaped with far *less* loss, if they could not have avoided the Cyclone, or perhaps without any, by due attention to our rules; and we can pretty nearly demonstrate also, that many which have foundered must have done so from utter ignorance of the danger they were running into!

7. The last case of which I have spoken is that in which you may often *profit* by a Cyclone. This is strange and startling enough, compared with the feeling of utter helplessness with which we all used, in former days, to regard these phenomena, but it is all comprised in these few words. *If circumstances allow you, sail along with it or run round it, instead of sailing through it.* Go back to the consideration of the wherry or canoe with the waterspout or whirlwind, at section 3, and you will at once see how this *may* be true. I shall now proceed to show you how it *is* true, and how you may *make* it true for yourself, at least in ordinary cases.

8. Bearing of the Centre of a Cyclone.—Considering then every Cyclone as a great whirlwind, of which the outer part, as to strength, is a common close-reefed topsail gale, such as no seaman cares for, and no seaworthy ship is hurt by, but of which the violence increases with great rapidity as the centre is approached, till close to, or *at* it, it becomes of destructive fury. And considering also the centre, though it may be a space from one to perhaps fifty miles in diameter, as a mere point, round which the whole storm is revolving, our first care must be to find how this point or centre bears from us; for this is what guides us in our future consideration and manœuvres.

9. This is simple enough when the Cyclone has fairly and unequivocally commenced; I mean both as regards the state of the weather and the fall of the barometer. The

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* Getting stern-way.—This taking aback in a tempest we all know to be most dangerous, not only on account of the getting stern-way, here mentioned, being pooped, dismasted, and the like; but from another danger, which is not sufficiently adverted to I think; and this is, that a vessel, may, in one of the terrific gusts which accompany these sudden shifts of wind, be thrown on her broadside in the trough of the sea, with her deck *towards* the sea! In such a case, and I have many instances of the kind on record, she is in the position of a vessel which has fallen over to seaward on a reef; and there is every chance that her hatches would be beaten in, which might swamp her, or that if her bulwarks are too high and solid she may be kept down by the weight of water on deck. Hatches are not usually made strong enough.

seaman should then mark off his place on his charts, and placing that horn card which belongs to the hemisphere he is in, upon it, *with the wind's place, as marked on the outer circle, over the ship's place*, he will see at a glance how the centre bears from him; thus in the Northern hemisphere with the wind at E. N. E., the centre of the card, which is that of the Cyclone, will be seen to bear S. S. E. from the ship, if at the East due South, and at E. S. E., S. S. W. of her, and so on.

In the Southern hemisphere again, a N. W. wind would give the centre bearing S. W., and a S. S. E. wind would give it bearing E. N. E., and so on successively. In a word, every wind will be a minute tangent to a circle of greater or less diameter, and for practical purposes we consider the centre bearing about at right angles to it.

10. As seamen however are not accustomed to consider the winds as tangent lines to a circle, and the bearing of the centre perpendicular to them, the consideration of "how the centre bears," even with the aid of the storm card, may hence sometimes be found puzzling.

11. Ascertaining the Track of a Cyclone.—The seaman now I presume knows how to estimate the bearing of the centre from him; but as there are still great tracts of the globe, though much frequented by shipping, in which we are ignorant of what may be the tracks of Cyclones, it may be as well to give here the method by which a careful commander may, approximately at least, estimate what is the track of an approaching Cyclone, or of one towards which he thinks he is running. He will find it useful to do this, not only in parts where the tracks of Cyclones are unknown, but also where they are pretty well ascertained. He should always, in a word, look on the centre of the hurricane as a privateer, or a pirate, or an enemy of superior force, and make his calculations for avoiding its neighborhood. He must not forget, that if he has *his* course and drift, the storm has also a course of *its* own, and brings with it currents, to both of which he must attend. Recollecting this, he may now farther use his storm card, with his log, to judge how the Cyclone itself is travelling, in the following manner.

If it be supposed that the Cyclone is travelling from the S. E. to the N. W., it will be seen that, supposing the ship in any part of the circle, this will give different changes of the wind to what would occur if it were travelling, say from E. N. E. to the W. S. W. An allowance being made for the ship's track between any two changes of wind, he will find that the line between the two points occupied by the centre of the circle, will lie in a direction which is *nearly* that of the track of the storm; and that in all which follows, he will only do what he does when sailing in fine weather along shores of which he has no exact chart: he takes the bearings of two head-lands, guesses their distance, and from his run lays down a sketch of the trending of the coast.

12. The track is estimated by projection, as in the diagram p. 6.

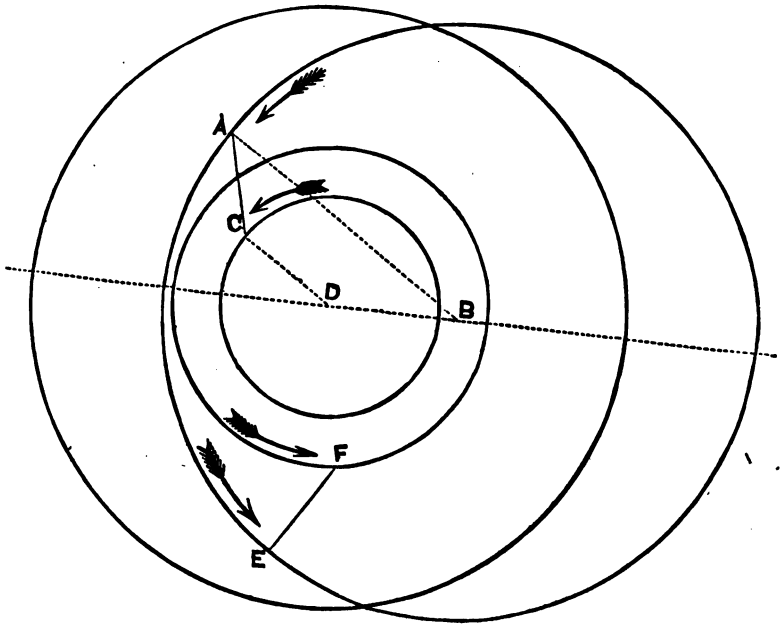
Draw a small line through the ship's place at A, in the direction of the wind, which we will call N. E., and another A B, from the same point, perpendicular to it, or S. E., which represents about the bearing of the centre of the Cyclone from the ship, at that time, in the Northern hemisphere.* We can only *guess* at the distance, which we do by estimating it from the violence of the wind, the rapidity of its changes, and the fall of the barometer. I should say, that, for a strong gale, which would allow a good merchant ship to carry her closed-reefed topsails and foresail, we might allow two hundred miles. For a hard gale, in which the foresail could scarcely be borne, one hundred and fifty or one hundred miles, and for a very severe gale, a still shorter distance. The veering of the wind, the increase of its forces, and the fall of the barometer, are, of course, more rapid the nearer you are to the centre, and some storms are also more violent and travel faster than others.

Let us, then, put down one hundred and fifty miles on this S. E. line, or from A to B, for our present distance from the centre of the Cyclone, and in six hours afterwards let us suppose the ship to have made fifty-four miles on a South course, bringing her to C, and that the wind is increasing fast, but is still at N. E., with the barometer falling, and every other appearance of bad weather.

Mark off this run of 54′ on a South line, and as the wind is still at N. E., draw a S. E. line as before, which points again towards the centre. We have to consider now that we are probably nearer to it than before, for we know that *it* also, in these six hours, has been travelling to the Westward between eight and sixteen miles at the least, and the barometer has continued to fall, and the squalls are much more violent and frequent. Taking twelve miles an hour, or seventy-two miles for the six hours in the compasses, we find that this distance from B will strike upon the S. E. line (which is the perpendicular to the wind's course, and now the bearing of the centre) at D, which we may thus take to be the new place of the centre. This, it will be seen, gives the Cyclone a

* True, and not compass points of the wind, should be used when the variation is considerable, if it be intended to consult the chart, or the track estimated from the compass, wind and course should be corrected for variation.

W. N. W. course, which is a likely one, and places the ship now at only fifty-eight miles from its centre. It is clear, therefore, that we are thus running in upon it, and though our distances are mere guesses, they are, for the Bay of Bengal and the China or Caribbean Sea, *very strong probabilities*, because of the continued fall of the barometer, and the great mass of evidence which exists to prove, that at certain seasons almost all their violent storms are Cyclones, and move from the Eastward to the Westward.



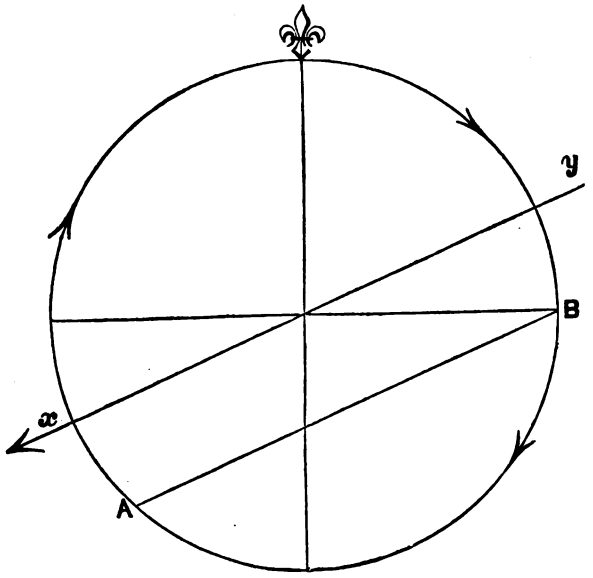
Scale 100′ *to an inch.*

13. Again: we may suppose, off the coast of North America, a ship in lat. 40° North, with a Cyclone evidently setting in at S. E. by S., and that in a run of six hours, at ten miles per hour, or sixty miles, to the W. N. W., the wind has only veered two points, and become S. E. by E., but has increased in strength very considerably and rapidly, and with a falling barometer. The projection of this will give us a Cyclone coming up from the S. Westward, as usual thereabouts, and we are thus right in its track. As it may in such a case be impossible or hazardous to scud on account of sea and wind, and the dread of the dangerous shift, we have in such a case to consider *what will be the proper tack to lie on?* which will be shown in the next section.

14. In consulting his charts, and judging therefrom, and from his log, and the veering of the wind, what the probable track of a Cyclone may be, the seaman must bear in mind, that, first we have no ground for any certainty that the tracts of one year will be *exactly* those of another; and next, that while the tracks of some Cyclones on all the charts are laid down, so to say from the logs of a whole fleet of ships; others, such as those near the Channel, some in the Southern Indian Ocean, &c., are necessarily laid down from the logs of one or, at most, two vessels, and this often without either having experienced the shift by the passage of the centre over her, but in all cases from there being sufficient evidence to show that the gale *was* a Cyclone travelling at *about* a certain distance from the ship on about a certain track. Our evidence for the tracks is, in fact, of all degrees of certainty from careful estimation, based on reasonable proofs, up to what may fairly be called mathematical certainty.

15. The track of a Cyclone may be judged of also from the shift, though some seamen may be embarrassed in considering accounts of storms by others, or from their own logs, to judge what *was* the track of the storm from the shift of the wind at the centre, but nothing is more simple. It may be done by the eye with the horn card; but if exactness is required, it should be done by projection. Thus, I suppose, in the Southern hemisphere, that a ship, lying to, has the shift from S. E. to North. See Fig. 1.

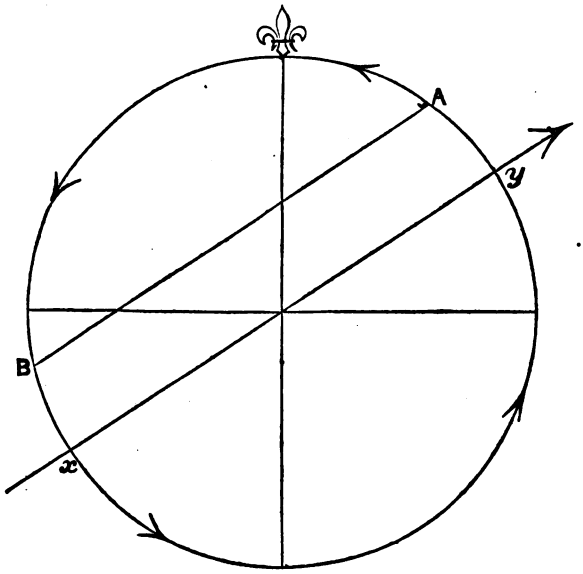
Fig. 1.



Strike any circle, cross it with diameters, and mark on it the S. E. Cyclone or *wind-point* of the storm card for that hemisphere, which will be on the lower part of the left hand side, at A, or in the S. W. quadrant of the circle; then mark the North *Cyclone-point*, which will be where the diameter to the right touches the circumference at B; join these two, and draw a parallel x, y, through the centre of the circle. Measure off the angle B. y or its complement from the *fleur de lis* to y, and it will give the compass track; which in this case is *from* E. N. E. to W. S. W., or from y to x, because the shift being *from* the S. E. to the North, the Cyclone must have been moving to the left, or from B to A to strike the ship first at A.

Again, suppose in the Northern Atlantic a shift from S. E. by E. to N. by W (See Fig. 2.)

Fig. 2.



Here, as before, A is the *Cyclone-point* of S. E. by E. (or compass N. E by N.), in the Northern hemisphere, and B of N. by W. (or compass W. by S.) Join them, and d

the parallel, *x y* through the centre of your circle, and the angle between the *fleur de lis* and *y* is the compass rhumb of the Cyclone's track; and as the wind, this time, was at first blowing from the S. E. by E. you see the Cyclone must have been *travelling up* from the left hand, or from B up to A, or on a track *from* the S. 55° W. to the N. 55° E. or from *x* to *y*. I need not add that the seaman in these essays must of course take the average direction of his winds when the Cyclone is at full strength, before and after the shift. He will also understand how, without any sudden shift, when the wind has only *veered* rapidly with him, so as from any one point to settle for some hours at another, it was travelling on a given track, and he was to the North or South of the centre, though no distinct calm interval occurred, which is often the case.

16. RUNNING OR HEAVING TO.—Every seaman, of course, begins by considering this question with reference to his sea-room. In what follows, I shall suppose throughout that he *has* sea-room, and that either because he has a fair wind in the Cyclone, or because he wants to profit by it, or wants to get out of its way, or has a leaky or crank ship, making lying to dangerous, he desires to scud, or wishes to know what he had better do. He has also, of course, by this time a correct notion of how the centre of the Cyclone bears from him, and for many parts of the world what are the usual tracks, or he has calculated pretty nearly what the track of the one he is engaged in is, from his previous run and the veering of the wind, as shown at page 5. He has now to consider if he is, with relation to these *two* data, the bearing of the centre of the Cyclone and its track—

A. *Behind it.*

B. *On either side of it, at about right angles to its track.*

C. *Before its track.*

Now (A) his precautions must be directed if *behind* the Cyclone.

In scudding,

(1.) Not to run into the heart of it.

(2.) Not to run too far *before* and then gradually across it.

(3.) Not to lose the advantages he may derive from it.

In heaving to,

(1.) To do so on the right tack.

(2.) To be careful when bearing up not to overtake it again; and therefore—

(3.) Not to bear up too soon.

Or (B) his precaution *if on one side* of a Cyclone at about a right angle to its track must be.

In scudding,

(1.) To scud *with* it, but not to edge too far into it—*i. e.* to keep at a safe distance from the centre.

(2.) Not to over-run it, and be thus led to cross into, and before it, if he has not full sea-room, and time to do so.

In heaving to, to do so on the right tack.

And (C) his precautions when *before* the track of the storm must be in this, which is the most difficult case, for it is that of a Cyclone "coming down" upon him.

In scudding,

(1.) To be careful that he can do so in a direction which will take him out of the way of the centre.

(2.) That he has full *time* (allowing always at least from ten or fifteen to twenty miles an hour for the Cyclone's rate of travelling) to get out of the way of the centre.

(3.) That if already in part, as it were, out of the way of the focus (*i. e.* when there is every probability that it will pass *near* but not over him), he does not by scudding, put himself more fully in the way of it.

(4.) To see if, by hauling up (should wind and sea, and the condition and qualities of his ship allow of this), and *then* heaving to when the Cyclone by approaching becomes of full strength, he cannot get farther towards its border, and thus more surely at a distance from the dangerous central focus.

In heaving to,

(1.) To heave to on the right tack for the shift and for "coming up" to the wind as it changes, instead of breaking off.

(2.) When the calm centre reaches the ship to keep the vessel's head the right way to avoid being taken aback, if he can do so.

17. The following diagram of a Cyclone in the Northern hemisphere, travelling to the E. N. E., as in the Northern Atlantic, will show this more distinctly. In it the ships *A*, *H*, *I*, *M*, on the outer circle at the four cardinal points are pursuing safe tracks *round* the Cyclone; the ship *M* having carefully, but at some risk, of course, to cross in front of it.

In the next circle *O*, *T*, *U*, and *V*, finding themselves too far in, are all doing their best to get *out* of the Cyclone circle, as they understand their position and have plenty of sea-

W, *X*, *Y*, and *Z*, are all "carrying on" to get farther *into* it; and while *W*, *Y*, and

Z, are standing right in to cut off the centre, if they can reach it in time, *X* is chasing it as hard as wind and sea will allow him, and will run on till he broaches to, and is dismasted or upset.

We may call *S* one of that class of the old school who still affirm that "you should always heave to in a hurricane," and we see that he has done so—on the wrong tack, and will just drift into the centre as it passes, and be taken aback by the shift from the North.

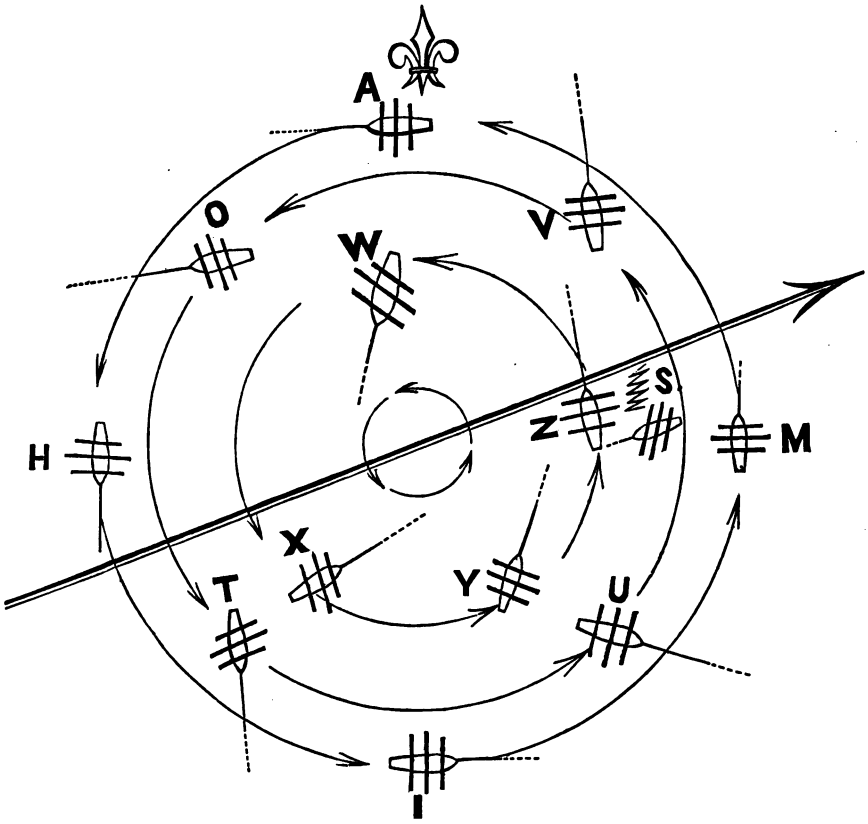
18. If the page be held up with the face of the cut to the light, it will then represent on the reverse a Cyclone in the Southern hemisphere, travelling to the W.N.W.,* the letters distinguishing the ships being chosen so as to appear rightly placed when so looked at also.

19. It will perhaps be useful if we try to give an extract from the imaginary logs of each of these ships, and this will not be so much pure invention as the reader may at first suppose; for I believe that, either from my own materials (published and unpublished) or those of other writers on the science, I could produce instances of every kind of management and *mis*management which I shall here set down.

Log of *A* (*bound to the Southward*). "Finding the wind, sea, and squalls increasing rapidly with a falling barometer, and all the signs of a Cyclone, of which the centre is to the South of us, bore up to allow it to pass," &c.

Log of *I* (*bound to N.E.*) "We have a Cyclone evidently passing to the North of us. Kept away East to allow it to pass, so as not to approach too near to the centre."

Log of *M* (*bound to the North*). "After all due calculation I am of opinion that we are so far in the direct track of the Cyclone to the W.S.W. of us, that we have yet time safely to cross in front of it. All hands called, head braces stretched along, good hands to the helm, hatches battened down," &c., &c.



Log of *H* (*bound to the E.S.E.*) "As we are evidently overtaking the Cyclone, bore up South to get well on the S. Western quadrant before hauling up, so as not to plunge

* Though this is an unusual track there.

farther into it. Tremendous confused sea while crossing; no doubt from the the Cyclone."

Log of *T* (*bound to the E. N. E.*) "Gale and squalls becoming terrific, with sea and barometer falling; bore up to run farther out of the Cyclone circle."

Log of *X* (*bound also to the E. N. E.*) "Gale and squalls excessively severe vessel behaving beautifully and steering to a quarter of a point———. As in a terrific squall, the wind shifted to S. S. E., which brought us by the lee. Be helm could be put over and the head yards braced round, we were driving frightful rate against the former sea; paid off, but in a few minutes had lost mizen masts," &c.

Log of *Y* (*bound to the N. E.*) "Tremendous gales and sea. At 9 A. M. it with a sea which was rising in mountain peaks on all sides of us, and running in direction. Ship perfectly unmanageable. At 11 A. M. a terrific burst of a hu down with a roaring noise like thunder, taking us flat aback. Bowsprit went in one heavy plunge, and finding the vessel would not pay off, down with the lee gunwales far below the water, cut away the main mast,"

Log of *Z* (*bound to the N. N. W.*) "Finding it impossible to run any longer dead before the wind, hove to on the starboard tack. At 11 A. M. a sudden shift from S. S. E. to N. N. W. taking us flat aback, lost topmasts, boats, booms, and e on deck."

Log of *W* (*bound to the S. S. W.*) "Running under close-reefed main and fore and main trysail, broached to by a heavy quartering sea; lost topmasts, sprung foremasts, three feet water in the hold. Head of the rudder split, and two of pintles gone," &c., &c.

Log of *S* (*bound to the South Eastward*). "Gale very severe; every sign of

proaching hurricane. Hove to, &c. In a few hours calm with shift throwing the vessel on her beam ends against a heavy sea, and obliging us to cut away mizen mast," &c.

20. The mariner (I mean the careful man who conscientiously endeavors to do his duty to his country or his owners) will now, I hope, easily see how simple it is, first to ascertain his position with respect to the bearing of the centre, and then what line of management it will be best for him to adopt; and he will no more consider the time as lost in these brief calculations than he would that which at the approach of a dark stormy night, near a dangerous passage, he devotes to weighing carefully whether it will be better to stand on, or to heave to, or work to windward, or anchor.

21. I desire to be understood by those who may read and consider all this, and indeed for the whole of this work, that I quite appreciate, and fully allow for, the differences between the smart and well-found man-of-war, with her well-disciplined and numerous crew, and her tried and trained officers, and the ill-found, half-manned merchantman, with her best hands on the sick list; or (I grieve to say) too often her grossly insubordinate, or incapable officers and ship's company: and I am well aware how safely the commander of the first can calculate upon his officers, his men, and his ship, to the hour and the minute, and how little the last can venture upon the chance that in two or three hours he may have far worse, or better, weather; but writing for all, I explain as clearly as I can the danger and the prudent course, and each must calculate for himself what his ship, his officers, and his crew can bear and do in the hour of need, if it comes.

22. THE USE OF THE TRANSPARENT HORN CARDS.—To explain this, I suppose I have to show them for the first time to a plain seaman, or to a very young officer who knows nothing about them, and by following with a little patience the steps laid down in the following lessons, there are none who will not, I trust, be able quickly, not only to understand it themselves, but to explain it to others.

23. Clearly to understand the horn cards the learner should first consider one of them attentively, when he will see that in the middle the eight points of his common compass cards are laid down to guide his eye, but that the *circles* represent the winds as they may be blowing in a Cyclone, *and that these winds are always as tangents to the compass points*. Thus in the Northern hemisphere the N. E. wind is marked at the N. West point of the compass, and so on. It is this confounding the wind points (or wind tangents) with the compass points on the storm-card, because they are both on the same card which sometimes confuses a learner.

The first and most useful lesson the plain seaman can give himself in this new science is, to obtain the habit of considering that all winds *may* be, and many certainly are *not blowing in straight lines, but in curves*. This is not so easy; for we are all habituated from our childhood to consider the wind both as blowing, "where it listeth," and also in a straight line from one point to another,* so that we are a little puzzled when we must think of the (apparently) straight lines shown by our dog-vanes and weather cocks, or by the trim of the sails of a whole fleet, or the furious gusts of a squall or hurricane, as only parts of a great curve.

The best way to form a good notion of this is to take a common map of any kind, on a large scale, say on that projection on which the parallels of latitude are great curves, and put a dot on one of the parallels for your ship's place. Now, putting the hands, or two pieces of paper, so as to cover a parallel of latitude all but an inch, or half an inch, on each side of our dot-ship, you will readily see then how the folks on board of her might suppose and affirm *their* wind to be a straight line, just as you do at sea of *your* wind; and yet you can see that it is part of a great curve which *might* be also part of a circle of several hundred miles in diameter. It is indeed supposed by Professor DOVE and Mr. REDFIELD that *all* winds from circuits, which would make them all curve in some part, if not in the whole of their courses.†

The next lesson to give one-self is this. When you have obtained the habit of recollecting that the wind, though apparently blowing in a straight line for you, is, or may be, really blowing in a curve forming part of a circle or ellipse, then *on what part of the circle* or ellipse you are? Say the wind is at North; you may suppose according to the hemisphere you are in, that you are on the East or the West side of a circle; and so on of every other wind, as in the table given on page 25.

Making marks for ship's positions on a sheet of paper or an old chart, and putting the

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* Just as we talk of the *level* of the sea, many landsmen using the word as if it applied to a horizontal and not a curved surface of about eight inches to a mile.

† If we suppose a Cyclone of three hundred miles in diameter, and thus (in round numbers) a little more than nine hundred miles in circumference, and thirty-two ships placed round the circumference, each with a wind one point different from its neighbor, they would still be twenty-nine miles apart. Many of the gradual changes of the wind from quarterly to a-beam, close-hauled, and breaking of from the course, are probably owing to these circuital winds as the ship runs on, though in fine weather. *There is no doubt that in tropical countries the wind is often blowing in circular vortices though not rising to the force of a storm.* This remark, which I now print in italics, closed the note in the first edition; and again, while I was writing this in India, Col. REID was collecting undoubted proofs of it at Bermuda.

transparent car ' over them, so as to see by it *how the centre bears* from the ship, is the next lesson, and will be found highly useful, for it is not every seaman who has the habit of considering his present wind a minute tangent line only, and the centre of a storm lying, according to the hemisphere he is in, at a perpendicular from that tangent. The *habit* of thus considering the wind, is what will give the plain seaman a complete understanding of the theory. He can always refer to the table in p. 25 to see if he is correct, and he will find it to be a sort of "boxing the compass at right angles," which every one has not got. If, whenever you look at the dog-vane or a weathercock, you make a rule of considering the wind also as a tangent line to a circle, in either hemisphere, you will quickly master this difficulty. "How is the wind, Mr. ——— ?" "S.S. W., sir," (*and if it is part of a Cyclone in the* Northern / Southern } *hemisphere the centre bears* { W.N.W. / E.S.E. } *of us.*)

The next lesson is to move the storm cards, each in their own hemisphere—for with them *you have the hurricane in your hand* recollect—over an island, or a fixed mark of any sort to represent a ship lying to, on a chart, and to notice how the effect of a vortex of any size, if so moving, would produce the changes of wind, of which we read; supposing always that we move the storm card along the right *track*:* As across the Leeward Islands from the S.E.; along the coast of North America from the S.S.W. or S.W.; in the China Sea from between N.E. and S.E. to the S.W. and N.W., &c.; for, as will be easily seen, *if the track of the storm varies, the changes of the wind also vary*, and if in either hemisphere a storm came, for instance, from the West instead of the East, the changes would be exactly opposite.†

The seaman should next mark off a ship's place, real or supposed, with her run or drift for any given number of hours, and then, moving up the storm card near or across this, observe how the motion of the storm *and* this run or drift induce different, or more rapid, changes of the wind, or take a ship out of, or run her headlong into a storm. These preliminary lessons may appear trivial, but they are not so; and the seaman who will give them a little attention, will find great advantage from so doing. I need, I hope, remind none that when bad weather is coming on they will have other matters to attend to than studying *then* the applications of the science; and that it is the cool and patient consideration of emergencies in fine weather, and at leisure, that makes the able and ready seaman when a crisis arrives.

If a small hole is drilled at the centre of the horn card, just large enough to admit the point of a pencil, and a mark be made on a sheet of paper to represent an island or a coast town, or a ship hove to, and the wind's place at the outer circle of the card, be put over this, while a pencil point is held in the hole, it will be seen how in moving the card so as to make the successive changes of wind pass over the island (or *near* it, allowing for the drift if a ship is supposed) the pencil point will trace out the track of the Cyclone's centre.

24. I now proceed to apply all this by practical lessons in various parts of the world for the uses of the storm card on horn, which will be found in the pocket of the cover for the Northern hemisphere.

The following rules must be borne in mind:

1.—The card may be supposed to represent any sized storm from twenty to five l dred miles in diameter, and as many more circles may be supposed to be added to i may be necessary to suit the scale of the chart.

1.—The *fleur de lis* must always be kept on the *magnetic* meridian when using it.

3.—It was always to be placed so, that the *wind's place* (or Cyclone Point) is over the *ship's place*.

4.—It is to be moved as required along the known, or estimated, track of the storm.

25. Special Examples for the Use of the Storm Cards. For the West Indies.—Mark off the place of a ship in lat. 16° North, long. 50° West, and suppose her bound to Trinidad.

The weather and barometer indicate the approach of a hurricane or severe gale, and the wind is at E. by N.

Now place the card so that part of the outer circle which lies between East and E.N.

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* The seaman and student will find it convenient to have two bullets flattened and covered with silk and a piece of narrow red tape about eighteen inches long, stitched to the inner side of each; these may be laid down in any direction on a chart, and will represent the track of the focus of a storm very distinctly as a sort of "Line of mischief," over which the card may be conveniently moved at pleasure, and the changes perfectly noted.

† He should next mark off *two* ships' places, and move his storm card so as to pass the centre between them, noting how the wind will *veer* with each ship, though the whole hurricane is *turning* according to the law of its hemisphere. If he sets these down on a piece of paper he will see at once how the contradictory accounts of winds veering and "backing round," as it is called, are perfectly true, though till now inexplicable.

may lie over the ship's place, and it will be seen that if this is a Cyclone* the centre t bears S. by E. *or thereabouts* from you.

Next, that it is hereabouts that the West Indian, Atlantic, and American coast storms seem to take their rise, and that they travel hence, as far as yet known, on a track to the Northward of West, but rarely so far so as Northwest, W. by N. or W. N. W. hen, is probably about its track, and fifteen or eighteen miles its rate of *sailing* in that irection.

I suppose your sea to be not yet *very* heavy, so that with the wind at E. by N. and every chance of its becoming more Northerly, your ship sound, and crew hardy and smart, with plenty of good helmsmen among them, the temptation to run on is very great; but you see also in a moment that, if you do, you will cross before, within, or close behind, or at the very centre of the Cyclone, and that you will thus, as it were, thrust yourself, if not into the jaws of destruction, certainly into a useless peril. Now as no man runs headlong into a waterspout when backing his main-yard for ten minutes can keep him out of it, your prudent course is to lie to, and allow the Cyclone to travel ast you, and the rise of your barometer and the gradual veering of the wind to the ithward of East will show you that it has done so, and all you have then to be careful ut, when standing on, is not to *overtake* the Cyclone, should it by any chance be a slow moving one: see p. 8 for your various considerations and chances.

26.—Suppose your ship in 16° North and 72° West with all appearances of a Cyclone, the wind at W. N. W., and she is bound to Grenada. Mark off her place, and lay the *W. N. W.* of the horn card over it; and you see at once that it is a storm of which the centre lies about N. N. E. from you, *i. e.* between you and the shores of St. Domingo, which it is probably then ravaging; and you moreover see that, for you, it is a fair wind by which you may safely and surely profit; hauling first a little to the Southward to be sure of a good offing from the more violent and dangerous part, and also to get room to keep away a little if the sea should be heavy when you get on the S. Eastern quadrant of the Cyclone, when the wind, as you see, will haul to the S. W.

27.—Suppose you are bound from New Orleans to the Havana, and that at a day's from the first port you begin to have a falling barometer, a heavy sea, squalls, gloomy ather, &c., and "half a gale" from E. N. E.

With the old knowledge we should all, certainly, "carry on" to this, and keeping the wind about a point before the beam, push on for our port under double reefs, with a close lookout on the steerage. But place the storm card on the chart, and you will see that if you do so you will be rapidly plunging into the Cyclone.

But you need not therefore heave to, for you will note that the hurricanes hereabouts all travel between the E. N. E. or N. Easterly to North and even N. Westerly. It is clear then that you *can profit by it by sailing round it*, i. e., keeping away West, W. S. W., S. W., S. S. W., and South, as your barometer guides you, and thus make a curve around the heel of the storm, and which will not be a large one; for as *it* is probably flying ten or twenty miles an hour on *its* track while you are, in the beginning of the storm, and if the track be one to the Eastward of the meridian, going wholly the other way, the wind will veer at first so rapidly, if the track is to the Eastward of the meridian, that you will be surprised to find how soon your Easterly gale is at North, N. W. and West, just as your storm card shows. If however it should be one of the Cyclones which, like *M*, *L*, or *E*, have tracks to the Westward of the meridian, it is evident that this may be merely scudding *with* the storm, if its track is very Westerly, or crossing the track before the centre, and perhaps much too near for safety. This will be quickly known by the veering or steadiness of the wind and if it is supposed that the track *is* one of these, the plan is to heave to on the starboard tack, being in the right hand semicircle.

28.—In the Northern Atlantic. A ship from Boston bound to Bermuda at 200 miles S. E. of Cape Cod, meeting a N. Easterly gale with a falling barometer and other indications of a hurricane Cyclone, will clearly understand also why she has her choice of running into the heart of the Cyclone, at the risk of being dismasted or upset, if she persists on her direct course as long as she can stand on, or of sailing round the Western edge of it, and thus at the expense of a little curve in her track making a fair wind for her whole voyage.

29. While correcting this, I read the account of the *Great Western* steamer committing the old blunder of *steaming into* a Cyclone in the Atlantic Ocean, in which she was nearly lost. She had it beginning at S. W. and veering gradually to N. N. E. Her drift in distance steamed, in the interval of thirty-six hours, is not given, but it is clear that she was on the South side of a Cyclone travelling about from West to East, taking her to have steamed and drifted about one hundred miles to the N. W.

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* The fall of the barometer and the appearance of the weather are in all common cases sufficient to distinguish it from the trade rising to the strength of a gale, as trade winds and monsoons sometimes do.

In the same Cyclone a royal mail steamer from the West Indies to Bermuda having met the Cyclone on her track, slacked her speed to allow the centre to pass her, and made a fair wind of its southern quadrants to her port.

30. A vessel from Europe, bound say to New York, meets with a strong S. S. Easterly gale and falling barometer, about the meridian of Bermuda. Here the seaman will observe, by the tracks and his storm card, that he is on the *Eastern side* of the Cyclone, which is travelling *towards* him on an E. N. E. or Northeastly course, and that if he stands on he will inevitably meet it. To run off to the N. W. till he has brought the wind to at least E. N. E. or N. E. and his barometer is rising, would be the means of getting out of the way of the centre; but it is very uncertain what are the sizes of the Cyclones hereabouts, and the distance he might have to run; most seamen will probably therefore prefer heaving to and allowing the centre to pass them, when the wind will become a fair one.*

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* It has been noted before that these situations, when a ship is directly on the average track of the Cyclone, are those of the greatest difficulty on two accounts. It is difficult to say beforehand, unless great attention has been paid to the run and veering of the wind, on *which* side of the track the vessel is; and the rate of travelling is here a serious question on which everything depends, and it is difficult therefore to judge if by running off for a few hours we shall really be getting farther *out* of the way. In the instance given above, the centre bears about W. S. W. and the track may be due E. N. E. *or* N. E. If it be only E. N. E. there might be time to cross in front and round the Northern verge of the storm; but if it be travelling N. E. the wind and sea may become too heavy to allow of standing on, and the run made would then only have brought the vessel directly into the path of the focus; with the encumbrance of her sail, if she meets it unexpectedly. Nevertheless there may be many cases, such as urgent service, chasing, and the like, in which the sails, and even the chances of the masts going with them, are not worth considering, and it is therefore proper that the seaman should have all the resources and the risks before him, for it is not impossible that a case might occur in which he might by clever manœuvring inflict a share, at least, of the latter on an enemy. Every experienced officer can tell how often in coast cruising the chase escapes by her superior knowledge of the winds and currents.

OBSERVATIONS

ON THE

HURRICANES AND STORMS

OF THE

WEST INDIES

AND THE

COAST OF THE UNITED STATES.

BY W. C. REDFIELD.

From a careful attention to the progress and phenomena of some of the more violent storms which have visited the Western Atlantic, I have found that they exhibit certain characteristics of great uniformity. This appears, not only in the terminate course which these storms are found to pursue, but in the direction of wind and succession of changes which they exhibit while they continue in action. The same general characteristics appear also to pertain, in some degree, to many of the more common variations and vicissitudes of winds and weather, at least in the temperate latitudes. The following points I consider as established:

1. The storms of greatest severity often originate in the tropical latitudes, and, not unfrequently, to the Eastward of the West India Islands; in the tropical regions they are distinguished by the name of *hurricanes*.

2. These storms cover, at the same moment of time, an extent of contiguous surface, the diameter of which may vary, in different storms, from one hundred to five hundred miles, and in some cases they have been much more extensive. They act with diminished violence towards the exterior, and with increased energy towards the interior, of the space which they occupy.

3. While in the tropical latitudes, or South of the parallel of 30°, these storms pursue their course, or are *drifted* by the natural atmospheric current of the region towards the West, on a track which inclines gradually to the Northward, till it approaches the latitude of 30°. In the vicinity of this parallel, their course is changed somewhat abruptly to the Northward and Eastward, and the track continues to incline gradually to the East, towards which point, after leaving the lower latitudes, they are found to progress with an accelerated velocity.

The rate at which these storms are found thus to advance in their course, varies in different cases, but may be estimated at from 12 to 30 miles an hour. The extent to which their course is finally pursued, remains unknown: but it is probable that, as they proceed, they become gradually extended in their dimensions, and weakened in their action, till they cease to command any peculiar notice. One of the hurricanes of August, 1830, has been traced in its daily progress, from near the Caribbee Islands to the coast of Florida and the Carolinas, and thence to the banks of Newfoundland, a distance of more than 3,000 miles, which was passed over by the storm in about six days. The duration of the most violent portion of this gale, at the different points over which it passed, was about 12 hours, but its entire duration was, in many places, more than twice that period. Another hurricane which occurred in the same month, passed from near the Windward Islands, on a more Eastern but similar route, and has also been traced in

daily stages by means of the journals and reports of voyages, near two hundred miles. It was in this storm that the Russian corvette, [illegible] Ramsey, suffered so severely. The hurricane of August, 1831, [illegible] Island of Barbadoes on the 10th of that month, the daily pr[illegible] been ascertained, passed in nearly a direct course to [illegible] of Mexico and New Orleans, where it arrived on the [illegible] passed over a distance of twenty-three hundred statute [illegible] Barbadoes.* Many cases of like character might be adduced.

4. The duration of the storm, at any place within its track, depends upon its extent and the rate of its progressive velocity, as these circumstances are found to determine the time which is required for the storm to pass over any given locality falling within its route. Storms of smaller extent or dimensions are usually found to move from one place to another with greater rapidity than larger storms.

5. The course thus pursued by the storm, is found to be entirely independent of the direction of wind which it may exhibit at the different points over which it passes—the wind in all such storms being found to blow after the manner of a whirlwind, around a common centre or vortex, during their entire progress, and in a determinate direction or course of rotation, which is from *right to left* (or in the direction from West to South) horizontally. The direction of the wind, therefore, for the most part, does not coincide with the course of the storm.

6. In the lower latitudes, while drifting to the Westward, the direction of the wind at the commencement, or under the most advanced portion of these storms, is from a *Northern* quarter, usually at some point from North-east to North-west, and during the latter part of the gale, it blows from a Southern quarter of the horizon, at all places where the whole effect of the gale is experienced.

7. After reaching the more Northern latitudes, and while pursuing their course to the Northward and Eastward, these storms commence with the wind from an Eastern or Southern quarter, and terminate with the wind from a Western quarter, as will appear more distinctly under the three following heads, the latter portion of the storm being usually attended with broken or clear weather.

8. On the outer portion of the track, North of the parallel of 30°, or within that portion of it which lies *furthest* from the American coast, these storms exhibit at their commencement a *Southerly* wind, which as the storm comes over, *veers gradually to the Westward*, in which quarter it is found to terminate.

9. In the same latitudes, but along the *central portion of the track*, the first force of the wind is from a point near to *South-east*, but after blowing for a certain period it *changes suddenly*, and usually after a short intermission, to a point nearly or directly opposite to that from which it has previously been blowing, from which opposite quarter it blows with equal violence till the storm has passed over, or has abated. This sudden change of a South-easterly wind to an opposite direction, *does not occur towards either margin of the storm's track*, but only on its more central portion, and takes effect in regular progression along this central part of the route, from the *South-west* towards the *North-east*, in an order of time which is exactly coincident with the progress of the storm in the same direction. It is under this portion of the storm that we notice the greatest fall of the barometer, and the mercury usually begins to rise a short time previous to the change of wind. In this part of the track the storm is known as a *South-easter*, and is usually attended with rain previous to the change of wind, and perhaps for a short time after.

10. On that portion of the track which is *nearest* the American coast, or which is farthest inland if the storm reaches the continent, the wind commences from a more Eastern or North-eastern point of the horizon, and afterwards veers more or less gradually, by North, to a North-western or Westerly quarter, where it finally terminates. Here also the first part of the storm is usually, but not always, attended with rain, and its latter or Western portion with fair weather. The first or foul-weather portion of the storm is, on this part of its track, recognized as a *North-easter*.

It should be noted, however, that near the latitude of 30°, and on the shores of Carolina, where the storm enters obliquely upon the coast, while its track is rapidly changing from a Northwardly to an Eastwardly direction, the wind on the central track of the storm will commence from an Eastern or North-eastern point of the compass, and will gradually become South-easterly as the storm approaches its height.

11. A full and just consideration of the facts which have been stated, will show conclusively that the portion of the atmosphere which composes for the time being the great body of the storm, whirls or blows as above stated, in a horizontal circuit, around a vertical or somewhat inclined axis of rotation which is carried onward with the storm; that the course or direction of this circuit of rotation is from *right to left;* and that the storm operates nearly in the same manner as a tornado or whirlwind of smaller dimensions;

* The tracks of these and other hurricanes appear on the annexed chart.

the chief difference being in the more disk-like form of the whirling body and the magnitude of the scale of operation.* This view of the subject, when fully comprehended, affords a satisfactory solution of the otherwise inexplicable phenomena of storms, and will also be found to accord entirely with the fact which appears in the above statement, that in the phases or changes which pertain to a storm, the wind, on one margin of its track, veers *with the sun*, or from *left to right;* while under the opposite margin of the same storm it veers *against the sun*, or from *right to left;* for this peculiarity necessarily attends the progressive action of any whirlwind which operates horizontally.

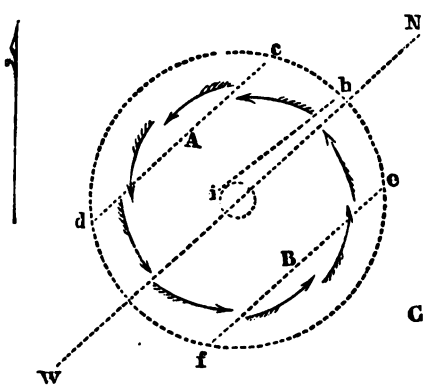
12. Owing to the centrifugal action of these rotative storms, the barometer, whether in the higher or lower latitudes, always sinks while under the first portion or moiety of the storm on every part of its track, excepting, perhaps, its extreme outward margin, and commonly affords us the earliest and surest indication of the approaching tempest. The mercury in the barometer always rises again during the passage of the last portion of the gale, and commonly attains the maximum of its elevations on the entire departure of the storm.

The great value of the barometer to navigators is becoming well understood, and its practical utility might be greatly increased by hourly entries of the precise height of the mercurial column, in a table prepared for the purpose. Its movements, unless carefully recorded, often escape notice or recollection; which may easily happen at those times when a distinct knowledge of its latest variations might prove to be of the greatest importance.

In the foregoing statements our design has been to designate in a summary manner the principal movements which, in these regions at least, constitute a storm; and we do not attempt to notice the various irregularities, and subordinate or incidental movements and phenomena of the atmosphere with which a storm may chance to be connected, or which may necessarily result from such violent movements in a fluid which is so tenuous and elastic in its character. It may be remarked in general, that the most active or violent storms are usually the most regular and uniform in the development of those characteristic movements which we have already described. It is also probable that the vortex or rotative axis of a violent gale or hurricane, oscillates in its course with considerable rapidity, in a moving circuit of moderate extent, near the centre of the hurricane; and such an eccentric movement of the vortex may, for aught we know, be essential to the continued activity or force of the hurricane. Such a movement will fully account for the violent *flaws* or *gusts* of wind, and the intervening *lulls* or remissions, which are so often experienced towards the heart of a storm or hurricane, when in open sea; but of its existence we have no positive evidence.

In Purdy's Memoir of the Atlantic Ocean, it is stated, "that while one vessel has been lying to in a heavy gale of wind, another, not more than 30 leagues distant, has at the very same time been in another gale equally heavy, and lying to with the wind in quite an opposite direction."

This statement is obviously to be understood as applicable to two vessels falling under the two opposite sides or portions of the same storm, where the wind in its regular circuit of rotation must, of course, blow from the opposite quarters of the horizon. We will suppose one of the vessels to be at A and the other at B, in the annexed figure.



The storm, in pursuing its course from W. towards N., will strike the first-mentioned vessel in the direction which is shown by the wind-arrows at the point *c*, which, if the position be in the temperate latitudes, North of 30°, will be from Eastward. Now, it is obvious, that as the storm advances in its course North-eastward, this vessel, if nearly stationary, will intersect the body of the gale on the line *c* A *d*. As the storm advances, the wind must also veer to the Northward, as shown by the arrows, being at N.E. when the vessel is brought under the point A; and near the close or departure of the storm by its further progress Eastward, the wind will have further veered to the direction shown at *d*, which, with due allowance for the

* It is to be understood that the diameter of the whirlwind which constitutes the storm is commensurate with the width of the track over which the storm passes. The main body of the storm is supposed to move in the form of an extensive disk, whirling around its own centre as it advances in its regular track—with this difference, that the rotative movement is far more rapid in the interior portions of the whirling body, than towards its exterior limits.

progressive motion of the storm, we will set down at N.N.W. The other vessel, as equally obvious, will first take the wind from the Southward, as shown at *c*, in [illegible] quarter it will blow, with no great variation, till, by the advance of the storm, th[illegible] is brought under the point B. The barometer, which had previously been fa[illegible] will now commence rising, and the wind, veering more Westerly, will, at the depar[illegible] of the storm, be found in the direction shown at *f*, which, after the allowance already referred to, may be stated at W.N.W. Such, substantially, are the facts commonly reported by vessels which fall under the lateral portions of the Atlantic storms; and it is readily seen, that the opposite winds which are exhibited on the two different intersections of the storm, as above described, will very naturally be mistaken for two separate and distinct gales.

The phases of the wind in these gales are, however, in all cases modified more or less by the course or changing position of the vessel exposed to its action. For example: a ship on taking the gale, say at E.S.E., at the point *h* on the figure, and lying to with her head to the Northward, may by that means be brought to intersect the storm on the line *h i*, and at the point *i* would suddenly be taken aback, with the wind, say at N.N.W., as in the case of the Jamaica homeward-bound fleet in 1788; and the barometer, which reaches its lowest depression under the central portion of the storm, would about this period be found to have commenced rising with some degree of rapidity.

A further reference to the figure will show that a ship, which may be at the [illegible] G during the passage of the gale, would be exposed to a heavy swell from the S[illegible]ward and Westward; but, being beyond the organized limits of the storm, may r[illegible] entirely unaffected by the violence of the wind, which at the same time may be [illegible] with destructive fury at the distance of a few leagues. The writer has knowl[illegible] of many such examples.

It has been suggested that the "port tack is the proper one to lie to on, as the wind will then be found to draw aft;" but this will frequently prove erroneous, as the wind may draw either way, on either tack, according to the position and course of the ship, in the storm, and the extent and rate of progress of the latter. In the case of [illegible] fleet which encountered the gale of 1782, it was probably the best course to carry [illegible] to the Northward at the very commencement of the gale, and as far and as long as possible. By this means the fleet might, perhaps, have been drawn as far Northward as the point A on the figure, and the change of wind to the Northward and Westward would have been rendered more gradual. The chief difficulty and danger is, when the direction of the wind, at the first setting in of the gale, is found to be nearly at right angles with the known course of the storms in the region where the gale is encountered, and it is then desirable to pursue such a course as to avoid, if possible, falling into the heart of the storm.

It frequently happens that a storm, during the first part of its progress over a given point, fails to take effect upon the surface, while it exhibits its full activity at a greater altitude. This commonly happens when this portion of the storm arrives from, or has recently blown over a more elevated country, or is passing or blowing from the land to the sea. On land, the most violent effects are usually felt from those storms which enter and blow from the open ocean upon the shores of an island or continent. Upon the latter, under such circumstances, the *first* part of the gale is usually the most severe, and that coast of an island upon which a storm first enters, or blows, also suffers most from the early part of the gale; but its later, or receding part, often acts with the greatest fury upon the opposite side of the island, which had previously derived some degree of shelter from the intermediate elevations and other obstacles opposed to the force of the wind, the benefit of which is now lost by its counter-direction from the open ocean. Owing to similar causes, the force of the storm is sometimes very unequal at different places, situated in nearly the same part of its track, and such inequality as we have before intimated, necessarily pertains to two places, one of which is near the centre and the other towards the margin of the route.

Of the multitude of facts by which these views might be illustrated, we will only [illegible] in the [illegible] at Barbadoes, that of August, 1831, the trees near the [illegible] coast of the island lay from N.N.W. to S.S.E., having been prostrated by a [illegible] in the [illegible] of the storm, while in the interior and some other [illegible] of the island they were [illegible] from South to North, having fallen in the [illegible] The [illegible] advices that were received from the islands of [illegible] which lay near the Northern margin of [illegible] these islands; but it afterwards [illegible] suffered damage from this [illegible] after it passed over the [illegible] the coast of Georgia and the [illegible] from these tempests, while little or no injury is [illegible] from the coast. One of the most [illegible] which in open sea is often

known to extend itself on both sides of the track, entirely beyond the range of the gale by which it was produced. The last hurricane to which we have alluded, threw its swell with tremendous force upon the Northern shores of Jamaica, having passed to the Northward of that island.

So strong is the influence of our established modes of thinking on this subject, that it seems to be difficult, even for those who admit the rotative character of these hurricanes, to understand correctly the true bearing and relations of the different phases of the wind which are presented at two or more points or places visited by the same storm, unless the subject has been thoroughly and carefully studied. Speculative opinions, also, upon a course of a storm, are usually, if not always, founded upon the erroneous notion of a rectilinear course in the wind. In the accounts received of the hurricane at Barbadoes, on the 3d September, 1835, which raged for a few hours from E.N.E., fears were expressed for the safety of the islands to the Northward; but subsequent intelligence from Guadaloupe and Martinico showed that the gale had not extended to these islands. Had the direction and changes of the wind in this storm been viewed in their true relations, it would have been perceived that the heart of the gale must have passed to the Southward of Barbadoes; and, as a general rule in the West India latitudes, where the onset of the storm is found to be in the general direction of the trade wind, or more Eastward, the observer may consider himself as under the Northern verge of the gale; but if the onset of the gale be from the North-westward, veering afterwards by West to the Southern quarter, the heart of the storm will be found to have passed to the Northward of the point of observation, the latter being under the Southern margin of the gale.

In order to illustrate the foregoing statements, I annex a chart of the Western Atlantic, on which is delineated the route of several hurricanes and storms, as derived from numerous accounts which are in my possession, by which their progress is specifically identified from day to day, during that part of their route which appears on the chart.

The route designated as No. I, is that of the hurricane which visited the islands of Trinidad, Tobago, and Grenada, on the 23d June, 1831. Pursuing its course through the Caribbean Sea, it was subsequently encountered by H. M. schooner Minx, and other vessels, and its swell was thrown with great force upon the South-eastern shores of Jamaica, on the 25th, while passing that island, where the wind, at this time, was light from the Northward. After sweeping through the Caribbean Sea, this hurricane entered upon the coast of Yucatan, on the night of Juue 27, having moved over the entire route from Trinidad to the Western shore of the Bay of Honduras, in a little more than a hundred hours, a distance of about seventeen hundred nautical miles, which is equal to nearly seventeen miles an hour. I have no account of this storm after it crossed the peninsula of Yucatan, and it is probable that it did not again act with violence upon the ocean level. Its course of track to Honduras was N 74° W.

Track No. II. is that of the memorable hurricane which desolated Barbadoes on the night of August 10, 1831, and which passed Porto Rico on the 12th, Aux Cayes and St. Jago de Cuba on the 13th, Matanzas on the 14th; was encountered off the Tortugas on the 15th, in the Gulf of Mexico on the 16th, and was at Mobile Pensacola, and New Orleans on the 17th; a distance of 2000 nautical miles in about 150 hours, equal to something more than 13½ miles an hour.* Its course, until it crossed the tropic of Cancer, was N. 64° W., or W. N.W., nearly. In pursuing its Northern course, after leaving the ocean level, it must have encountered the mountain region of the Alleganies, and was perhaps disorganized by the resistance opposed by these elevations. It appears, however, to have caused heavy rains in a large extent of country lying North-eastward of the Gulf of Mexico.

Track No. III. is that of the destructive hurricane which swept over the Windward Islands on the 17th of August, 1827; visited St. Martin's and St. Thomas' on the 18th; passed the North-east coast of Hayti on the 19th; Turk's Island on the 20th; the Bahamas on the 21st and 22d; was encountered off the coast of Florida and South Carolina on the 23d and 24th; off Cape Hatteras on the 25th; off the Delaware on the 26th; off Nantucket on the 27th; and off Sable Island and the Porpoise Bank on the 28th. Its ascertained course and progress is nearly 3000 miles,† in about eleven days; or at the average rate of about eleven miles an hour. The direction of its route, before crossing the tropic, may be set down at N. 61° W.; and in latitude 40°, while moving Eastward, at N. 58° E.

Track No. IV. is that of the extensive hurricane of September, 1804. It swept over the Windward Islands on the 3d of that month; the Virgin Islands and Porto Rico on the 4th; Turk's Island on the 5th; the Bahamas and Gulf of Florida on the 6th; the coast of Georgia and the Carolinas on the 7th; the great bays of Chesapeake and Delaware, and the contiguous portions of Virginia, Maryland, and New Jersey, on the 8th; and the states of Massachusetts, New Hampshire, and Maine, on the 9th; being on the highlands of New-Hampshire a violent snow-storm. The destructive action of

* Mr. Purdy states that this gale was felt at Natchez, 300 miles up the Mississippi.

† All distances are expressed in nautical miles.

this storm was widely extended on both sides the track indicated upon the chart, and the same fact pertains, in a greater or less degree, to the other storms herein mentioned. It appears to have passed from Martinico, and the other Windward Islands, to Boston, in Massachusetts, by the usual curvilinear route, in about 6 days; a distance of more than 2200 miles, at an average progress of about 15½ miles per hour.

Track No. V. represents the route of the hurricane which ravaged the Islands of Antigua, Nevis, and St. Kitt's, on the night and afternoon of August 12th, 1835; St. Thomas, St. Croix, and Porto Rico, on the 13th; Hayti and Turk's Island on the 14th; the vicinity of Matanzas and Havana on the 15th; was encountered off the Tortugas, in the Gulf of Mexico, on the 16th; in lat. 27° 21′, long. 94°, and other points, on the 17th and 18th; and also at Matamoras, on the coast of Mexico (lat. 26° 4′,) on the 18th, where it was most violent during the succeeding night.* This storm is remarkable, as moving more directly, and further to the West, than is usual for storms which pass near the West India Islands, it having reached the shores of Mexico before commencing its sweep to the Northward. Its course, so far as known, is N. 73° W. Its progress more than 2200 miles in 6 days, which is nearly equal to 15½ miles per hour.

Track No. VI. is that of the memorable gale of August, 1830, which, passing close by the Windward Islands, visited St. Thomas on the 12th; was near Turk's Island on the 13th; at the Bahamas on the 14th; on the gulf and coast of Florida on the 15th; along the coast of Georgia and the Carolinas on the 16th; off Virginia, Maryland, New Jersey, and New York on the 17th; off George's Bank and Cape Sable on the 18th; and over the Porpoise and Newfoundland Banks on the 19th of the same month; having occupied about 7 days in its ascertained course from near the Windward Islands, a distance of more than 3000 miles—the rate of its progress being equal to 18 miles an hour.† If we suppose the actual velocity of the wind, in its rotary movement, to be five times greater than this rate of progress, which is not beyond the known velocity of such winds, it will be found equal, in this period, to a rectilinear course of 15,000 miles. The same remark applies, in substance, to all the storms which are passing under our review. What stronger evidence of the rotative action can be required than is afforded by this single consideration?

Route No. VII. is that of an extensive gale, or hurricane, which swept over the Western Atlantic in 1830, and which was encountered to the Northward of the West India Islands on the 29th of September. It passed on a more Eastern route than any which we have occasion to describe, to the vicinity of the Grand Bank of Newfoundland, where it was found on the 2d of October, having caused great damage and destruction on its widely extended track, to the many vessels which fell in its way. Its course is quite analogous to that which we have considered as having been probably pursued by the hurricane of October 3d, 1780. The ascertained route may be estimated at 1800 miles, and the average progress of the storm at 25 miles an hour.

Route No. VIII. is that of a much smaller, but extremely violent hurricane which was encountered off Turk's Island on the 1st of September, 1821; to the Northward of the Bahamas, and near the lat. of 30°, on the 2d; and on the coast of the Carolinas early in the morning of the 3d; and from thence, in the course of that day, along the seacoast to New York and Long Island; and which, on the night following, continued its course across the States of Connecticut, Massachusetts, New Hampshire, and Maine. We are not in possession of accounts by which its further progress can be successfully traced.‡ The diameter of this storm appears not to have greatly exceeded 100 miles; its ascertained route and progress is about 1800 miles in 60 hours—equal to 30 miles an hour.

The last-mentioned route may also be considered to be nearly the same as that of a similar, but less violent storm, which swept along the same portion of the coast of the United States on the 28th of April, 1835.

No. IX. represents the route of a violent and extensive hurricane, which was encountered to the Northward of Turk's Island on the 22d of August, 1830; Northward of the Bahamas on the 23d; and off the coast of the United States on the 24th, 25th, and 26th of the same month.

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* Since the above was written, it is ascertained that this storm also passed over Galveston Bay, on the coast of Texas, where the hurricane blew with violence from the N.E., while at the mouth of the Mississippi, and along the Northern shores of the gulf, the gale was not felt. Such facts appear quite sufficient to overthrow the hypothesis of Franklin relating to North-east storms, and are equally fatal to the more common theories. At Galveston, this storm, in passing over, veered by East to the South-east: the rationale of which may be made evident by drawing a line through the Northern side of the figure on the chart, parallel to the track of the storm. A little further attention to the figure will also illustrate the general character of the Northers, which are so common on the coast of Mexico during a considerable portion of the year.

† For a more extended notice of this storm, see American Journal of Science, vol. xx. pp. 34–38.

‡ The phenomena and progress of this storm have been more fully noticed in Silliman's Journal, vol. xx. pp. 24–27.

Much damage was done on the ocean by this storm; but it scarcely reached the American shores. Its duration off this coast was about 40 hours, and its progress appears to have been more tardy than that of some other storms.

No. X. represents the track of a violent hurricane and snow-storm, which swept along the American coast, from the latitude of 30° N., on the 5th and 6th December, 1830.

The last-mentioned track also corresponds to that of another storm, of like character, which swept along the sea-coast on the 13th, 14th, and 15th of January, 1831. These violent winter-storms exhibit nearly the same phases of wind and general characteristics as those which appear in the summer and autumn.

Track No. XI. represents a portion of the general route of the violent inland storm which swept over the Lakes Erie and Ontario, on the 13th of November, 1835. This storm was very extensive, spreading from the sea-coast of Virginia into the Canadas, to a limit at present unknown. The anterior portion of this gale was but moderately felt, and its access was noted, chiefly by the direction of the wind, and the great fall of the barometer; the violence of the storm being chiefly exhibited by the posterior and colder portion of the gale, as is common with extensive overland storms. The regular progression of this storm in an Easterly direction is clearly established by facts, collected by the writer, from the borders of Lake Michigan to the Gulf of St. Lawrence, and the sea-coasts of New England and Nova Scotia.

We have thus given a summary description of the route of 12 storms or hurricanes, which have visited the American coasts and seas at various periods, and at different seasons of the year. The lines on the chart, which represent the routes, are but approximations to the centre of the track, or course, of the several storms; and the gales are to be considered as extending their rotative circuit from 50 to 300 miles, or more on each side of the delineations; the superficial extent of the storm being estimated both by actual information and by its duration at any point near the central portion of its route, as compared with its average rate of progress. The figure which appears upon the chart, on Tracks Nos. I., V., and VII., will serve, in some degree, to illustrate the course of the wind in the various portions of the superficies covered by the storm, and also to explain the changes in the direction of the wind which occur successively at various points, during the regular progress of the gale. The dimensions of the several storms appear also to have gradually expanded during their course.

Storms of this character do not often act with great violence on any considerable extent of interior country to which they may arrive. Even upon the coasts on which they enter, such violence is not often experienced under the posterior limb of the gale which sweeps back from its circuit over the land, the usual woodlands and elevations being a sufficient protection. Often, indeed, the interior elevations afford such a shelter as entirely to neutralize the effect of the wind at and near the surface, and the presence and passage of the hurricane is, in such cases, to be noted chiefly by the unusual depression which the great whirling movement of the incumbent stratum of air produces in the mercury of the barometer, which thus indicates the presence or passage of the hurricanes in positions where the force of the wind is not felt at all, or only with a moderate degree of violence. The action of these storms appears indeed, to be at first confined to the stratum or current of air moving next to the earth's surface, and they seldom, while in this position, appear to exceed a mile or so in altitude; and the course of the next highest or overlaying stratum does not, in these cases, seem to be at all affected by the action of the storm below. During the progress, however, by the influence of high land and other causes, the storms often become transferred, in whole or in part, to the next higher stratum of current. Thus we sometimes see a stratum of clouds moving with the full velocity of a violent storm, while the stratum of surface wind is nearly at rest, or moves with its ordinary velocity; and thus, also, it happens that balloons, ascending under such circumstances, are carried forward with a velocity of from 60 to 100 miles an hour. The foregoing remarks are by no means hypothetical, but are the result of long-continued observation and inquiry.

It will hardly escape notice, that the track of most of the hurricanes, as presented on the chart, appears to form part of an elliptical or parabolic circuit, and this will be more obvious if we make correction, in each case, for the slight distortion of the apparent course in the higher latitudes, which is produced by the plane projection. We are also struck with the fact that the vertex of the curve is uniformly found on or near the 30th degree of latitude. In connection with this fact it may also be noted, that the latitude of 30° marks the external limit of the Trade Winds, on both sides of the equator: and perhaps it may not prove irrelevant to notice, even further, that by the parallel of 30° the surface area, as well as the atmosphere, of each hemisphere, is equally divided; the area between this latitude and the equator being about equal to that of the entire surface between the same latitude and the pole. It is not intended, however, to make these facts the basis of any theoretical inductions on the present occasion.

A variety of deductions may be drawn from the general facts which we have stated, some of which, though deeply interesting to the philosopher and votary of science, might

be out of place in a nautical work of this description. I [illegible] bondage to existing theories in meteorology: and shall [illegible] proceed to notice a few of the more practical inferences [illegible] others, may, perhaps, be of no doubtful utility.

1. A vessel bound to the Eastward between the latitudes of 33° and 45° in [illegible] stern part of the Atlantic, on being overtaken by a gale which commences blowing from any point to the Eastward of S.E. or E S.E., may avoid some portion of its violence by putting her head to the Northward, and when the gale has veered sufficiently in the same direction, may safely resume her course. But by standing to the Southward, under like circumstances, she will probably fall into the heart of the storm.

2. In the same region, vessels, on taking a gale from S.E., or points near thereto, will probably soon find themselves in the heart of the storm, and after its first fury is spent, may expect its recurrence from the opposite quarter. The most promising mode of mitigating its violence, and at the same time shortening its duration, is to stand to the Southward upon the wind, as long as may be necessary or possible; and if the movement succeeds, the wind will gradually head you off in the same direction. If it becomes necessary to heave to, and the wind does not veer, be prepared for a blast from the North-west.

3. In the same latitudes a vessel scudding in a gale, with the wind at East or North-east, shortens its duration. On the contrary, a vessel scudding before a South-westerly or Westerly gale, will thereby increase its duration.

4. A vessel which is pursuing her course to the Westward or South-westward, in this part of the Atlantic, meets the storms in their course, and thereby shortens the periods of their occurrence; and will encounter more gales in an equal number of days than if stationary, or sailing in a different direction.

5. On the other hand, vessels while sailing to the Eastward or North-eastward, or in the course of the storms, will lengthen the periods between their occurrence, and consequently experience them less frequently than vessels sailing on a different course. The difference of exposure which results from these opposite courses, on the American coast, may in most cases be estimated as nearly two to one.

6. The hazard from casualties, and of consequence the value of insurance, is enhanced or diminished by the direction of the passage, as shown under the two last heads.

7. As the ordinary routine of the winds and weather in these latitudes often corresponds to the phases which are exhibited by the storms as before described, a correct opinion, founded upon this resemblance, can often be formed of the approaching changes of wind and weather, which may be highly useful to the observing navigator.

8. It will be perceived, from the foregoing facts, that the occurrence of a storm at a particular locality, has no immediate connection with astronomical periods, such as the changes of the moon, or the time of the equinoxes.

9. A due consideration of the facts which have been stated, particularly those under our twelfth head, will inspire additional confidence in the indications of the *barometer*, and these ought not to be neglected, even should the fall of the mercury be unattended by any appearances of violence in the weather, as the other side of the gale will be pretty sure to take effect, and often in a manner so sudden and violent as to more than compensate for its previous forbearance. Not the least reliance, however, should be placed upon the prognostics which are usually attached to the scale of the barometer, such as Set Fair, Fair, Change, Rain, &c., as in this region at least they serve no other purpose than to bring this valuable instrument into discredit. It is the mere rising and falling of the mercury which chiefly deserves attention, and not its conformity to a particular point in the scale of elevation.

10. These practical inferences apply, in terms, chiefly to storms which have passed to the Northward of the 30th degree of latitude on the American coast, but with the necessary modification as to the point of the compass, which results from the Westerly course pursued by the storm while in the lower latitudes, are, for the most part, equally applicable to the storms and hurricanes which occur in the West Indies, and South of the parallel of 30°. As the marked occurrence of tempestuous weather is here less frequent, it may be sufficient to notice, that the direction of the winds of the West Indian seas is from 8 to 11 points of the compass *more to the left* than on the coast of the United States in the latitude of New York.

Vicissitudes of wind and weather on this coast which do not conform to the foregoing specifications, are more frequent in April, May, and June, than in other months At this season it is not uncommon to find a regular current of Easterly wind prevailing for many days, producing sometimes heavy rains, and always an elevated state of the barometer. Easterly or Southerly winds under which the barometer rises, or maintains its elevation, are not of a gyratory or stormy character; but such winds frequently terminate in the falling of the barometer and the usual phenomena of an Easterly storm.

The typhoons and storms of the China sea and Eastern coast of Asia, appear to be [illegible] ar in character to the hurricanes of the West Indies and the storms of this coast.

when prevailing in the same latitudes. There is reason to believe that the great circuits of wind, of which the Trade Winds form an integral part, are nearly uniform in all the great oceanic basins; and that the *course* of these circuits and of the stormy gyrations which they may contain, is in the Southern hemisphere, in a *counter-direction* to those North of the equator, producing a corresponding difference in the general phases of storms and winds in the two hemispheres.

From the foregoing results we infer the value and importance of correct marine reports relating to violent gales. Those reports should always comprise the *date*, the *latitude and longitude*, and the *principal direction and changes of the wind.**

"HEAVING TO."

The recent disasters which have occurred to American ships, such as the Dorchester, Medora, Ambassador, and many others, have caused some inquiry, and it has been suggested by experienced men, borne out by the facts, that the disasters may be traced to the "heaving of ships to" on the wrong tack; that is, that vessels bound to the Westward from Europe, instead of "heaving to" with their port tacks on board, in a Southwest gale, as is too often the case, should "heave to" on the starboard tack.

It is well known that our heavy Westerly gales, in the winter season, often begin at the South or Southwest, and as they increase in intensity, haul round gradually, but oftentimes suddenly, in a squall, to the Northwest. Take, then, the case of a ship bound to the Westward, the wind commencing at the South or Southwest, the ship on the port tack; the master, anxious to get to the Westward, carries his canvas as long as possible, and continues on that tack until he has his ship under a close-reefed maintopsail, mizen staysail or trysail—in fact, "hove to" on the port tack, the sea making heavy from the Southwest, the wind keeps hauling to the Westward, and the ship falls off with it until she lays in the trough of the sea—the sea then having the control over, and breaking with its full force on the broadside, there is no canvas at this time set that she can ware under with safety—the ship is then disabled, and sometimes founders—the fact is, over anxiety to get to the Westward has kept the ship too long upon this tack.

Now, what is the best course to be adopted? We think that when it is blowing so hard as to make it necessary to furl the foresail, or head sails, previous to doing so, the ship should be wore round, and "hove to" on the starboard tack; and as the wind hauls, she comes up heading the sea more and more, until it is on the bow, and, of course, in the best position to avoid its shock.

Again, often the wind shifts so suddenly in a S. W. gale, that a ship is taken aback by being on the port tack, which is fearful at any time, and particularly so at such a time. Those who have experienced it on a winter's passage from Europe, with a crew worked down with hard weather, and on a dark night, can only imagine what a scene it is.

This cannot occur on being "hove to" on the starboard tack with a S. Westerly gale, but if the vessel is on that side of the Cyclone on which the wind hauls to the North by the way of East she should be hove to on the port tack.

REVOLVING STORMS IN THE NORTHERN HEMISPHERE.†

Gyratory Movements.—The space over which these circular storms have been known to expand themselves, varies from twenty or thirty to some hundreds of miles; blowing continually round and round a centre or vortex, but with ever-varying force, now lulling into little more than a strong breeze, and then suddenly swelling up into a blast of uncontrollable fury. But the peculiar characteristic of their revolving action is, that in each hemisphere of the world the gyration invariably takes place in one direction, and that direction contrary to the apparent course of the sun; so that in N. latitudes these storms revolve from right to left. The knowledge of this law is the more especially important, as it not only supplies the seamen with direct means of distinguishing them from common gales, but it reveals to him the actual position of the centre or vortex, with respect to the place of his vessel, and therefore points out with unerring certainty the way to escape from them.

Progressive Movements.—But besides the above circular motion of the wind round a centre, these storms have a bodily progressive movement, rolling onwards, if it may be so expressed, along their desolating tracks, somctimes with great volocity, and some-

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* For further remarks on Wind, see Blunt's American Coast Pilot, pp. 70* to 74*.

† Extracted from the pamphlet, Remarks on Revolving Storms, published by order of the Lords Commissioners of the Admiralty, 1853.

times appearing to pause or scarcely to advance more than a few [illegible] the b[illegible] although the impetuosity of the wind itself round the circle may [illegible] ished.

Regions Where Prevalent.—These storms occur commonly in the three great oc[illegible] the Atlantic, Indian, and Pacific, but they are seldom found within less than 5[illegible] of the equator, and have not yet been traced into very high latitudes. They appear to be most frequent and most severe in the West India, Madagascar, and China seas; and the season in which they are most prevalent is during the sun's return from the summer solstice; or, in other words, from July to October in the Northern hemisphere; and in the Southern regions, from January to April.

Direction of Movement.—Though these storms in traversing the ocean do not always adopt the same path, nor ever travel with any uniform velocity, yet there is so much apparent similarity in their movements as to show that they are ruled by one general law. To endeavor to trace this law, the log books of a great number of vessels in all parts of the sea, have been examined, as well as the meteorologic registers of numerous places on shore; and from them the movements of these storms have been reduced into comparative tables, their separate tracks graphically represented on charts, and their several characteristics analyzed with great labor and zeal by the before-mentioned authors.

The general result may thus be briefly stated: In all cases within the tropics, they commence to the Eastward; for some days they travel along a path not exactly W., but inclining a point or two towards the pole of that hemisphere which they are crossing; their rate of movement, though very variable, may be averaged at from ten to thirty miles in the hour; and as they advance they seem to be the more inclined to curve away from the equator. Occasionally they are found to cross the line of the shore, and to sweep over the land that opposes their progress; but by far the greater number seem to be repelled by any continental coast, and to be deflected back to the N. E. in the Northern hemisphere, and to the S. E. in the Southern hemisphere.

Vortex.—Another remarkable feature of these storms is their increasing violence in the neighborhood of their centre or vortex; and yet there, they are so much the more fitful and uncertain as to render a vessel absolutely helpless and unmanageable. Besides which, as she approaches the vortex (unless on the direct line of its own progressive motion), the more rapid become the changes of the wind, till at length, instead of its veering point by point, as she had found when entering the storm-field, it now flies round at once to the opposite point—the vessel is taken aback, or brought by the lee, in an irresistible squall—and forced into sternway against an overpowering sea, the destructive consequences of which need not be enlarged upon here.

Those who have dearly bought this experience, by having passed through the centre of one of these storms, describe the cross confused sea there as being tremendous—raised by gusts from every point of the compass into pyramidal heaps, which strike the vessel on either side, and with a force similar to that of a heavy surf beating over a reef. And yet, on the other hand, there are instances on record of the wind suddenly failing in the very vortex, and the clouds dispersing for a short and delusive interval, though soon, as if the wind had acquired fresh power from the transient calm, resuming its violence with tenfold fury. It may be added, that few vessels ever went through the ordeal of the vortex without losing either masts or rudder, or meeting with some worse disaster; and, therefore, at whatever cost of time, trouble, or loss of ground, the central part of the storm-field will be avoided by every man in his senses.

Prognostics.—Enough has been premised to convey a general idea of these singular storms, as well as of the danger of lingering within their baneful influence; and we shall now, therefore, endeavor to give a few succinct and simple rules by which they may be either wholly avoided, or by which, if the vessel be already too near to prevent the collision altogether, she may place herself so as to receive them in the least disadvantageous position, and extricate herself the most speedily from their grasp.

With that threatening aspect of the sky which generally precedes all storms—such as the greasy halo round the sun or moon, the rolled and tufted forms of the clouds, with their lurid streaks of light and extraordinary colors, the heavy bank clinging to the horizon with its darting forks and threads of pale lightning—every seaman is acquainted.

The best and surest of all warnings will, however, be found in that invaluable and seldom failing monitor, the barometer; the language of which, in the torrid zone, is unmistakable, because there it is usually so tranquil and undisturbed. When any such warning symptoms are observed in *any* quarter of the world, it may be supposed that no time will be lost in making all due preparation, and especially if to such menacing appearances be added the confused and troubled agitation of the sea which often precedes these revolving storms, and always shows that they are at no great distance. But if these combined prognostics should occur within the limits of those regions which have been already pointed out, let the seaman immediately consider the possibility at

least of his being about to encounter a storm of that revolving type of which we have been treating.

Relative Position of Storm.—Acting under this anticipation, his first care should be to discover the position of the storm with respect to the vessel, or, in other words, to ascertain its bearing. Fortunately this is a problem of extreme facility, for, as we have already stated, it is one of the remarkable laws of these storms that in the opposite hemispheres they revolve in opposite directions—in N. latitudes against the course of the sun, that is to say, from right to left, or in a direction contrary to the movement of the hands of a watch, and in S. latitude from left to right; and secondly, it is known that, no matter how great or how little may be the size of the storm-field, the wind continually blows in a circular course round and round a centre or vortex.

Position of Vortex.—It therefore necessarily and demonstratively follows that this centre must always be at right angles to that circular course; or, in other words, that the bearing of the centre lies eight points of the compass from the direction of the wind. Now, these two considerations are quite enough for our purpose, for they enable us to answer the question instantly and certainly by the following general rule:

Look to the wind's eye—set its bearing by the compass—take the eighth point to the *right* thereof—and that will be the bearing of the centre of the storm in N. latitude. For example: suppose the vessel to be in 14° N. latitude, the wind from E. S. E., and the barometer and sky indicating a coming gale—then, look at the compass, take the eighth point to the *right* of E. S. E., and S. S. W. will infallibly be the bearing of the brewing storm, *if it be* of a revolving type. In this case, the vessel will be on the Northern edge of the storm-field.

Nothing can be more definite and unambiguous than the above rule, requiring no diagrams nor any puzzling considerations to lead to a distinct and immediate conclusion; nevertheless, as the mind, when somewhat excited by the approach of such an unwelcome visitor as one of these storms, might possibly apply the eight points on the wrong side, we have added a table, for N. latitude, in which the seaman will at once see the question solved without the trouble of any reflection whatever

BEARING OF VORTEX IN NORTH LATITUDE.

If the Wind be,	The Vortex of the Storm will bear from the Ship,	If the Wind be,	The Vortex of the Storm will bear from the Ship,
North.	East.	South.	West.
N. by E.	E. by S.	S. by W.	W. by N.
N. N. E.	E. S. E.	S. S. W.	W. N. W.
N. E. by N.	S. E. by E.	S W. by S.	N. W. by W.
N. E.	S. E.	S. W.	N. W.
N. E. by E.	S. E. by S	S. W. by W.	N. W. by N.
E. N. E.	S. S. E.	W. S. W.	N. N. W.
E. by N.	S. by E.	W. by S.	N. by W.
East.	South.	West.	North.
E. by S.	S. by W.	W. by N.	N. by E.
E. S. E.	S. S. W.	W. N. W.	N. N. E.
S. E. by E.	S. W. by S.	N. W. by W.	N. E. by N.
S. E.	S. W.	N. W.	N. E.
S. E. by S.	S. W. by W.	N. W. by N.	N. E. by E.
S. S. E.	W. S. W.	N. N. W.	E. N. E.
S. by E.	W. by S.	N. by W.	E. by N.

Distance of Vortex.—The bearing of the storm from the vessel having thus been determined, it would no doubt be very desirable to ascertain, at the same time, its distance from her; but for this no very clear rules have yet been suggested. A good guess may, however, be made from the quickness or slowness with which the storm appears to develop itself—from the increasing severity of its squalls—from the faster veering of the wind—from the rising confusion of a cross swell—and especially from the sudden fluctuations of the barometer, which should be carefully noted every half hour whenever there is reason to suspect that a revolving storm is in the neighborhood.

How to compute it.—Some attempt may be even made to compute the distance of the vortex by its change of bearing from the vessel, assuming for that purpose some probable direction for its track, according to the general principle before-mentioned. For

instance, let us place a vessel in 14° N. latitude and 40° W. longitude. She meets there with strong indications of a gathering storm, and as the wind is E., she knows that if it be a revolving one, its vortex must bear S. In an hour's time she [illegible] is that the vortex has advanced so far to the Westward as to bear S. S. W., the wind [illegible] come gradually round to E. S. E.

Now, in the supposed position of the vessel, the path of the storm may be reasonably assumed to be W. N. W., and for our first trial we will take its rate of moving to be ten miles within that hour. With these data, enter the Traverse Table, with the change of wind, two points, as the course, and the advance or the vortex, ten miles, as the departure, and the corresponding distance, twenty-six miles, will be that of the vortex from the ship at the time of the first bearing, and twenty-four miles at that of the second bearing. If the storm has not yet reached abreast of the ship, so that one of its bearings may form a right angle with its path, the observer must be at the trouble of working out the result in an oblique triangle; and if, instead of lying to (as we have supposed her, in order to simplify the problem), she be herself in motion, the process will be somewhat more complicated.

Apparent Anomaly.—There is, however, so much of supposition and guess-work in either estimating or computing the direct distance of the storm, that no very precise result can be expected; but its discussion here will have helped to give a more distinct view of the nature of these storms, and to show in what sense they are said to be revolving. For, in the above example, the reader will have perceived that in the hour the wind had veered from E. to E. S. E.; and at first sight, therefore, he might be inclined to exclaim, that this change having been made *with* the sun, was in direct contradiction to the law, which has been so distinctly asserted in these pages, viz., that the wind in N. latitudes always blows round the axis or vortex in a *contrary* direction to the motion of the sun, and moreover, that it always preserves that direction in the whole series of concentric circles throughout the entire space over which the storm extends its influence. In reiterating that law, it may be added as one of its necessary consequences, that in all parts of the quarter of the circle contained between E. and N. the wind is and will continue to be from between S. and E., and in the N. W. quarter from between E. and N., &c.; and on any one radius, from the centre to the circumference, the wind will be always the same; so that if four vessels were involved in the same storm, one being on each of the four cardinal points of the compass, and on the same tack, they would all have their heads at right angles to each other.

If the vessel in the example, instead of lying to, had steered W., that is to say, on a parallel course to that of the storm and at the same progressive rate, her wind would not have changed, it would have continued at E., and the vortex would have continued to bear S., though in very dangerous and increasing proximity. Or, if the wind had much freshened, and the captain, being in ignorance of its revolving nature, had persevered in the Westerly course, with the idea of running away from the gale, that course, by its convergence towards the W. N. W. path of the storm, would have rapidly led her towards its centre, where she would either have suffered in proportion to its intensity or if she persisted in keeping right before the wind, she would have soon found herself in the ridiculous predicament of the *Charles Heddle*.

This brig sailed from the Mauritius in February, 1845, and falling in with a revolving gale from the Eastward, she at once put her helm up in order, as it is commonly said, "to run out of it," or let it "exhaust itself;" but the wind drew round and round, according to the now known laws of these circular storms, and she, with a perseverance that might have been more wisely employed, continued to scud "right before it" for four successive days and nights, by which time she had actually circumnavigated the storm-field five times. In performing this singular exploit she had kept at the end of a radius of about forty miles, and had run through the water upwards of thirteen hundred miles, though her real change of place (the joint result of the onward movement of the vortex and of the current) did not much exceed three hundred miles.

In the case before us, as the vessel was lying to, the storm *moved away from her* till it bore S. S. W., when, of course, the wind came to E. S. E.; and if she had made sail on the port tack, so as to cross the outer part of the field, she would have fallen off point after point, as the wind would have continued to change to S. E., S. S. E., and S.; and all these changes the reader will perceive were in the order of the sun's motion although each of those winds was duly continuing its course against the sun.

We have dwelt the longer on this part of the subject, because it is necessary that the seaman should clearly perceive that the changes of wind which occur to him in any part of the storm-field entirely depend on the relative position of his ship to the vortex; and moreover, that they may be correctly foreseen, and ought to be well considered before he determines on what measures to adopt—whether to lie to, or to fly from the danger—whether to avoid further entanglement with its various circles, or to endeavor to render them subservient to the progress of her voyage.

[illegible] Rule for Avoidance.—Few words will now be sufficient to give expression to

the one great general rule for all vessels, in all cases, except when controlled by land or shoals. Let them immediately steer in that direction which will most quickly increase their distance from the vortex, or centre of the storm-field. But then let it be remembered that the whole storm-field is itself in motion; that it is travelling with certainty to the Westward while within the tropics, though with very uncertain velocity; and that it has a tendency to curve round to the Northward in *Northern* latitudes, being repelled by the distant interference of a Western continent.

The situation of the vessel must therefore be considered, not only with respect to the present position of the vortex, but also with respect to the place to which it will have advanced by the time she may have executed any projected run; for otherwise, though going at her best speed, she might be overtaken by a following, and probably an expanding storm. When the progressive velocity of a storm is slow, a vessel may overtake and plunge into it; in which case the cross sea that follows in the "wake" of the storm may serve as a warning.

In the example that we have been discussing, the storm was nearly abreast of the vessel when first discovered, and seemed to be passing away innocuously to the Westward; but as the latter half of a storm-field is often pregnant with far greater mischief than the preceding half, and as it is generally attended by a much more turbulent sea, so a prudent commander would have led her off to the Northward, on the starboard tack, although perhaps she were bound to the Southward. Or if the wind or sea were not quite intolerable, he might possibly have continued lying to on the starboard tack, being certain that as the vortex was going off to the W. N. W. it would bear from him more and more Westerly, and consequently that his vessel would keep coming up to the wind without any danger of being taken aback in some of its sudden changes; this being a very material consideration in dealing with these changeful storms.

Example.—Let us now suppose a homeward-bound vessel, in a low Northern latitude, meeting a revolving storm in its progress to the Westward. The first of its winds that would reach her must be one of those belonging to the Western half of its circumference; let it be from N. N. E.; the vortex therefore would bear E. S. E., and she would thus be nearly in the direct line of its advance, the most critical of all positions. To lie to would only be waiting for the sure approach of the whole body of the storm; if put on the starboard tack, and lying N. W., she could scarcely widen her departure from its path soon enough to escape the tumultuous cross sea and terrific gusts which might pervade a large zone on either side of its path; besides which, the path itself might be already curving to the N. W. To cross the path to the N. W. would, therefore, be very dangerous, if not impracticable; and the only available resource will be to bear round up and steer between S. W. and S., according as there may be sea room; and if no valuable time is lost in coming to that decision, there are few cases in which this manœuvre may not be executed with impunity before the vortex comes so near as to develop its fury.

The exact course to be steered must be chosen according to circumstances; and the distance to be run off may be determined by the appearance of the sea, by the state of the barometer, and by the general feature of the storm, along with its changes of bearing to E. and N. E. as the wind veers to N. and N. W., which it will assuredly do in due time; but before this takes place the vessel will probably have been safely hauled to the wind on the port tack, and ready to proceed on her voyage when the barometer rises, and the sea becomes less turbulent.

Anomalies.—We have thus given a sketch of the general laws by which revolving storms appear to be guided, as well as of the general principles on which they may be avoided; and we have endeavored to do this with the utmost brevity, because our great object has been to awaken the seaman to the extreme importance of the subject, and to show the nature of the resources which prudence and foresight will place in his hands. But it is our duty to warn him that he must acquire a much more efficient knowledge than can be gathered from this little abstract of the leading phenomena which distinguish these storms; and he must also study their various anomalies and exceptions, for they have been known suddenly to intermit, and even to back round again in a contrary direction to their usual course; and sometimes they have been followed by a second storm, leaving a narrow intermediate space between the two circular areas, where a vessel has been alternately affected by each of them.

In conclusion, we earnestly call upon every mariner to keep a full register of the circumstances attendant on any of these storms with which he may come in contact; stating in detail the premonitory appearances—the quarter-hourly fluctuations of the barometer—the time of every change of wind—the conditions of the sea, the swell, and the weather—the measures to which he has had recourse, such as shortening or setting sail, altering the course, &c., as well as the reasons for their adoption; and finally, we would urge him to publish those accounts, or to transmit them to some proper quarter, for the information of others.

THE WEATHER.

Familiar as the practical use of weather-glasses is, at sea as well as on land, those who have long watched their indications, and compared them carefully, are not able to conclude more than that the rising glass* usually foretells less wind or rain; a falling barometer more rain or wind, or both; a high one fine weather, and a low on the contrary. But, useful as these general conclusions are, in most cases, they are sometimes erroneous, and then remarks may be rather hastily made, tending to discourage the inexperienced.

By attention to the following observations (the results of many years' practice and many years' experience), any one, not accustomed to use a barometer, may do so without difficulty.

The barometer shows whether the air is getting lighter or heavier, or is remaining in the same state. The quicksilver falls as the air becomes lighter, rises as it becomes heavier, and remains at rest in the glass tube while the air is unchanged in w

Air presses on everything within about forty miles of the world's surface, like a much lighter ocean, at the bottom of which we live, not feeling its weight because our bodies are full of air,† but feeling its currents, the winds. Toward any place from which the air has been drawn by suction,‡ air presses with a force or weight of nearly 15lbs. on a square inch of surface. Such a pressure holds the limpet to the rock when, by contracting itself, the fish has made a place without air‖ under its shell. Another familiar instance is that of the fly, which walks on the ceiling with its feet. The barometer tube, emptied of air, and filled with pure mercury, is turned down into a cup or cistern containing the same fluid, which, feeling the weight of air, is so pressed by it as to balance a column of about thirty inches (more or less) in the tube, where no air presses on the top of the column.

If a long pipe, closed at one end only, were emptied of air, filled with water, the open end kept in water and the pipe held upright, the water would rise in it more than thirty feet. In this way water barometers have been made. A proof of this effect is shown by any well with a pump, up which, as is commonly known, the water will rise nearly thirty feet, which is, in fact, the pressure of air.

It is not from the point at which the mercury may stand that we are alone to form a judgment of the state of the weather, but from its rising or falling, and from the movements of immediately preceding days as well as hours, keeping in mind effects of change of direction, and dryness or moisture, as well as alteration of force or strength of wind.

In this part of the world, toward the higher latitudes, the quicksilver ranges, or rises and falls, nearly three inches—namely, between about thirty inches and nine tenths (30.9) and less than twenty-eight inches (28.0), on extraordinary occasions; but the usual range is from about thirty inches and a half (30.5) to about twenty-nine inches (29.0). Near the line, or in equatorial places, the range is but a few tenths, except in storms, when it sometimes falls to twenty-seven inches.

The sliding scale (vernier) divided the tenths into ten parts each, or hundredths of an inch. The number of divisions on the vernier exceeds that in an equal space of the fixed scale by one.

By a thermometer the weight of air is not shown. No air is within the tube—none can get in—but the bulb of the tube is full of mercury, which contracts by cold and swells by heat, according to which effect the thread of metal in the small tube is drawn down or pushed up so many degrees, and thus shows the temperature.§

If a thermometer have a piece of linen round the bulb, wetted enough to keep it damp, by a thread or wick, dipping into a cup of water, it will show less heat than a dry one, in proportion to the dryness of the air and quickness of drying.¶ In very damp weather, with or before rain, fog, or dew, two such thermometers will be nearly alike.

For ascertaining the dryness or moisture of air, the readiest and surest method is the comparison of two thermometers, one dry, the other just moistened and kept so. Cooled by evaporation as much as the state of the air admits, the moist (or wet) bulb thermometer shows a temperature nearly equal to that of the other one, when the atmosphere is extremely damp or moist; but lower at other times, in proportion to the dryness of air, and consequent evaporation—as far as twelve or fifteen degrees in this

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* Glass, barometer, column, mercury, quicksilver, or hand.
† Or atmosphere, or the atmospheric fluid which we breathe.
‡ Or exhaustion.
‖ A vacuum.
§ Thirty-two degrees is the point at which water begins to freeze, or ice to thaw.
¶ Evaporation.

climate, twenty, or even more, elsewhere. From four to eight degrees of difference is usual in England, and about seven is considered healthy for inhabited rooms.

The thermometer fixed to a barometer, intended to be used only as a weather-glass, shows the temperature of air about it nearly, but does not show the temperature of mercury within exactly. It does so, however, near enough for ordinary practical purposes, provided that no sun, nor fire, nor lamp heat, is allowed to act on the instrument partially.

The mercury in the cistern and tube, being affected by cold or heat, makes it advisable to consider this when endeavoring to foretell coming weather by the length of the column.

Briefly, the barometer shows weight or pressure of the air; the thermometer, heat and cold, or temperature; and the wet thermometer, compared with a dry one, the degree of moisture or dampness.*

It should always be remembered that the state of the air foretells coming weather, rather than shows the weather that is present—an invaluable fact, too often overlooked, that the longer the time between the signs and the change foretold by them, the longer such altered weather will last; and, on the contrary, the less the time between a warning and a change, the shorter will be the continuance of such foretold weather.

To know the state of the air, not only barometers and thermometers should be watched, but the appearances of the sky should be vigilantly noticed.

If the barometer has been about its ordinary height, say near thirty inches (at the sea level),† and is steady, or rising, while the thermometer falls, and dampness becomes less, Northwesterly, Northerly, or Northeasterly wind, or less wind, less rain, or snow, may be expected.

On the contrary, if a fall takes place with a rising thermometer and increased dampness, wind and rain may be expected from the Southeastward, Southward, or Southwestward.

A fall with a low thermometer foretells snow.

Exceptions to these rules occur when a Northeasterly wind, with wet (rain, hail, or snow) is impending, before which the barometer often rises (on account of the direction of the coming wind alone) and deceives persons who, from that sign only (the rising), expect fair weather.

When the barometer is rather below its ordinary height, say down to near twenty-nine and one half inches (at the sea level), a rise foretells less wind, or a change in its direction toward the Northward, or less wet; but when it has been very low, about twenty-nine inches, the first rising usually precedes or indicates strong wind; at times heavy squalls from the Northwestward, Northward, or Northeastward—after which violence a gradually rising glass foretells improving weather if the thermometer falls; but, if the warmth continue, probably the wind will back (shift against the sun's course), and more Southerly or Southwesterly wind will follow, especially if the barometer rise is sudden.

The most dangerous shifts of wind, or the heaviest Northerly gales, happen soon after the barometer first rises from a very low point; or, if the wind veers gradually at some time afterward.

Indications of approaching changes of weather, and the direction and force of winds, are shown less by the height of the barometer than by its falling or rising. Nevertheless, a height of more than thirty (30.0) inches (at the level of the sea) is indicative of fine weather and moderate winds, except from E. to N. occasionally.

The barometer is said to be falling when the mercury in the tube is sinking, at which time its upper surface is sometimes concave or hollow; or when the hand (see note on next page) moves to the left. The barometer is rising when the mercurial column is lengthening, its upper surface being convex or rounded, or when the hand moves to the right (see note on next page).

A rapid rise of the barometer indicates unsettled weather; a slow movement the contrary; as likewise a steady barometer, which, when continued, and with dryness, foretells very fine weather.

A rapid and considerable fall is a sign of stormy weather and rain (or snow). Alternate rising and sinking indicate unsettled and threatening weather.

The greatest depressions of the barometer are with gales from S. E., S., or S W.; the greatest elevations, with wind from N. W., N., or N. E., or with calm.

Though the barometer generally falls with a Southerly and rises with a Northerly wind

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* The two thus combined make an hygrometer; for which some kinds of hair, grass, or seaweed, may be a makeshift.

† It differs, or stands lower, about a tenth of an inch for each hundred feet of height directly upward, or vertically, above the sea; its average height being 29.94 inches at the mean sea level in England. Allowances must, therefore, be made for barometers on high land or in buildings.

the contrary sometimes occurs when the Southerly wind is usually dry. The weather of the Northerly wind is then cold and accompanied by rain, snow, or perhaps with hail.

When the barometer has sunk considerably, high wind, rain, perhaps with hail, or with or without lightning. The wind will be from the Northward if the thermometer is low for the season—from the Southward when the thermometer is high. ... heavy gales of wind are attended by lightning only, while ... beyond the horizon.

Sudden falls of the barometer with a Westerly wind is sometimes followed by violent storms from N. W. or N. or N. E.

If a gale sets in from the E. or S. E. and the wind veers by the S., the barometer will continue falling until the wind is near a marked change, when a lull may occur; after which the gale will be renewed, perhaps suddenly and violently, and the veering of the wind towards the N. W., N. or N. E. will be indicated by the rising of the barometer with a fall of the thermometer.

Three causes (at least*) appear to affect a barometer:

1. The direction of the wind—the N. E. wind tending to raise it most—the S. W. to lower it the most; and winds from points of the compass between them proportionally as they are nearer one or the other extreme point.

N. E. and S. W. may therefore be called the wind's extreme bearings (rather than poles).

The range or difference of height shown due to change of direction only, from one of these bearings to the other (supposing strength or force and moisture remain the same), amounts in these latitudes to about half an inch (as read off).

2. The amount—taken by itself—of vapor, moisture, wet, rain, or snow, in the wind, or current of air (direction and strength of wind remaining the same), seems to cause a change amounting, in an extreme case, to about half an inch.

3. The strength or force alone of wind from any quarter (moisture and direction being unchanged) is preceded or foretold by a fall or rise, according as the strength will be greater or less, ranging, in an extreme case, to more than two inches.

Hence, supposing the three causes to act together—in extreme cases—the height would vary from near thirty-one inches (31.0) to about twenty-seven inches (27.0), which has happened, though rarely (and even in tropical latitudes).

In general, the three causes act much less strongly, and are less in accord; so that ordinary varieties of weather occur much more frequently than extreme changes.

Another general rule requires attention: which is, that the wind usually appears to veer, shift, or go round with the sun (right-handed, or from left to right),† and that when it does not do so, or backs, more wind or bad weather may be expected instead of improvement.

It is not by any means intended to discourage attention to what is called "weather wisdom." On the contrary, every prudent person will combine observation of the elements with such indications as he may obtain from instruments; and will find that the more accurately the two sources of foreknowledge are compared and combined, the more satisfactory their results will prove.

A barometer begins to rise considerably before the conclusion of a gale, sometimes even at its commencement. Although it falls lowest before high winds, it frequently sinks very much before heavy rain. The barometer falls, but not always, on the approach of thunder and lightning.‡ Before and during the early part of settled weather it usually stands high and is stationary, the air being dry.

Instances of fine weather with a low glass occur, however, rarely, but they are always preludes to a duration of wind or rain, if not both.

After very warm or calm weather, a storm or squall with rain, may follow; likewise at any time when the atmosphere is heated much above the usual temperature of the season.

Allowance should invariably be made for the previous state of the glasses during some days, as well as some hours, because their indications may be affected by distant causes, or by changes close at hand. Some of these changes may occur at a greater or less distance, influencing neighboring regions, but not visible to each observer whose barometer feels their effect.

There may be heavy rains or violent winds beyond the horizon and the view of an observer, by which his instruments may be affected considerably, though no particular change of weather occurs in his immediate locality.

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* Electrical effects are yet uncertain.

† With watch-hands in the Northern hemisphere, but the contrary in South latitude. This, however, is only apparent; the wind is actually circulating in a contrary direction.

‡ Thunder-clouds rising from Northeastward, against the wind, do not usually cause a fall of the barometer

It may be repeated that the longer a change of wind or weather is foretold before it takes place, the longer the presaged weather will last, and, conversely, the shorter the warning, the less time whatever causes the warning, whether wind or a fall of rain or snow, will continue.

Sometimes severe weather from the Southward, not lasting long, may cause no great fall, because followed by a duration of wind from the Northward, and, at times, the barometer may fall with Northerly winds and fine weather, apparently against these rules, because a continuance of Southerly wind is about to follow. By such changes as these one may be misled, and calamity may be the consequence if not duly forewarned.

A few of the more marked signs of weather, useful alike to seamen, farmer, and gardener, are the following:—

Whether clear or cloudy, a rosy sky at sunset presages fine weather; a red sky in the morning, bad weather or much wind (perhaps rain); a gray sky in the morning, fine weather; a high dawn, wind; a low dawn, fair weather.*

Soft-looking or delicate clouds foretell fine weather, with moderate or light breezes; hard-edged, oily-looking clouds, wind. A dark, gloomy blue sky is windy; but a light, bright blue sky indicates fine weather. Generally, the softer clouds look, the less wind (but perhaps more rain) may be expected; and the harder, more "greasy," rolled, tufted, or ragged, the stronger the coming wind will prove. Also, a bright yellow sky at sunset presages wind; a pale yellow, wet; and thus, by the prevalence of the red, yellow, or gray tints, the coming weather may be foretold very nearly; indeed, if aided by instruments, almost exactly.

Small, inky-looking clouds foretell rain; light scud clouds, driving across heavy masses, show wind and rain; but, if alone, may indicate wind only.

High upper clouds, crossing the sun, moon, or stars, in a direction different from that of the lower clouds, or the wind then felt below, foretell a change of wind.†

After fine, clear weather, the first signs in the sky of a coming change are usually light streaks, curls, wisps, or mottled patches of white distant cloud, which increase, and are followed by an overcasting of murky vapor, that grows into cloudiness. This appearance, more or less oily, or watery, as wind or rain will prevail, is an infallible sign.

Usually, the higher and more distant such clouds seem to be, the more gradual, but general, the coming change of weather will prove.

Light, delicate, quiet tints or colors, with soft, undefined forms of clouds, indicate and accompany fine weather; but gaudy or unusual hues, with hard, definitely-outlined clouds, foretell rain, and probably strong wind.

Misty clouds, forming or hanging on heights, show wind or rain coming if they remain, increase, or descend. If they rise or disperse, the weather will improve or become fine.

Dew is an indication of fine weather; so is fog. Neither of these two formations occurs under an overcast sky, or when there is much wind. One sees fog occasionally rolled away, as it were, by wind, but seldom or never formed while it is blowing.

Remarkable clearness of atmosphere near the horizon, distant objects, such as hills, unusually visible, or raised (by refraction),‡ and what is called "a good hearing day," may be mentioned among the signs of wet, if not wind, to be expected.

More than usual twinkling of the stars, indistinctness or apparent multiplication of the moon's horns, haloes, "wind dogs,"‖ and the rainbow, are more or less significant of increasing wind, if not approaching rain, with or without wind.

Near land, in sheltered harbors, in valleys or over low ground, there is usually a marked diminution of wind during part of the night, and a dispersion of clouds. At such times, an eye on an overlooking height may see an extended body of vapor below (rendered visible by the cooling of night), which seems to check the wind.

Lastly, the dryness or dampness of the air, and its temperature (for the season), should always be considered, with other indications of change or continuance of wind and weather.

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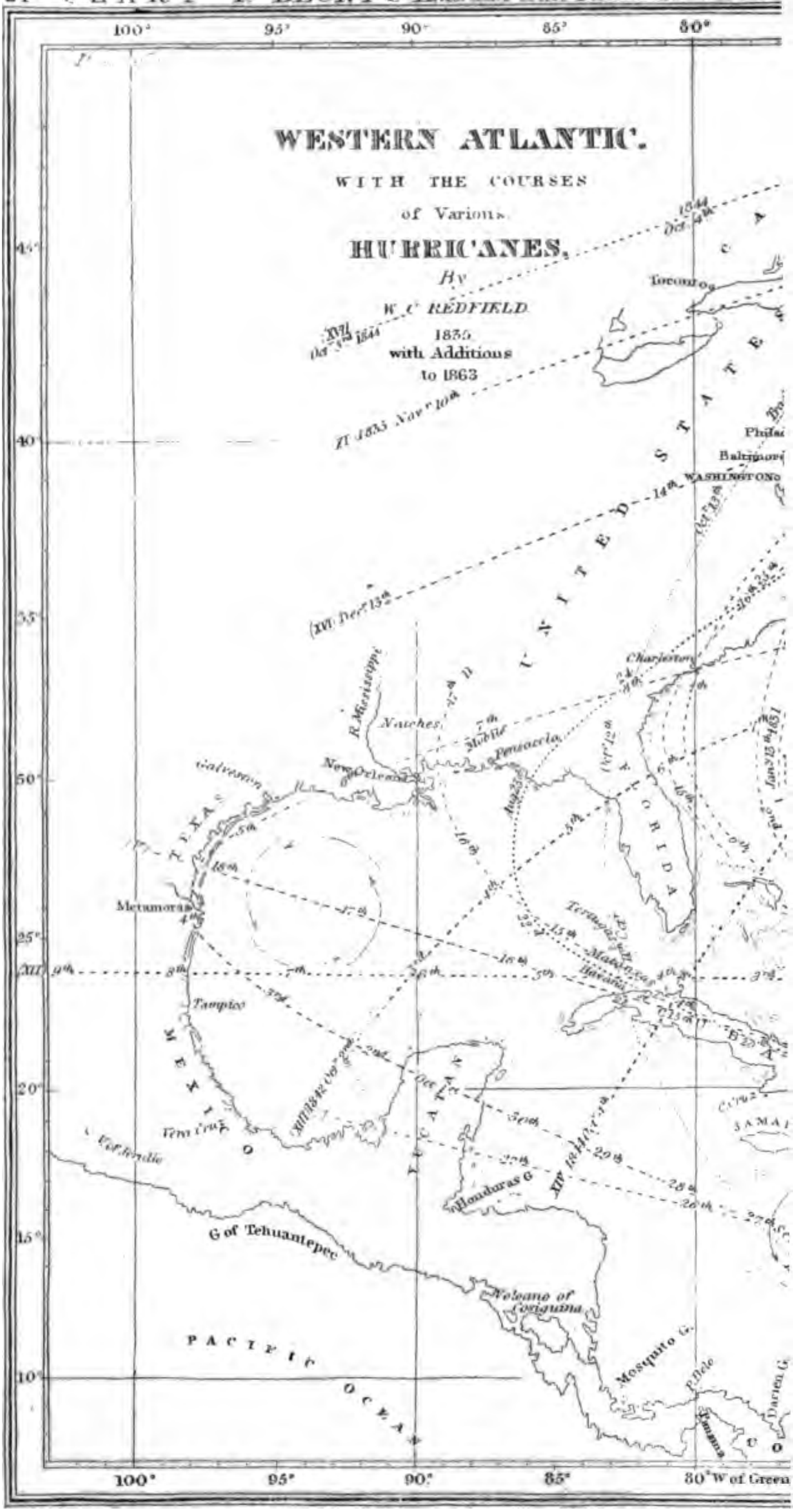
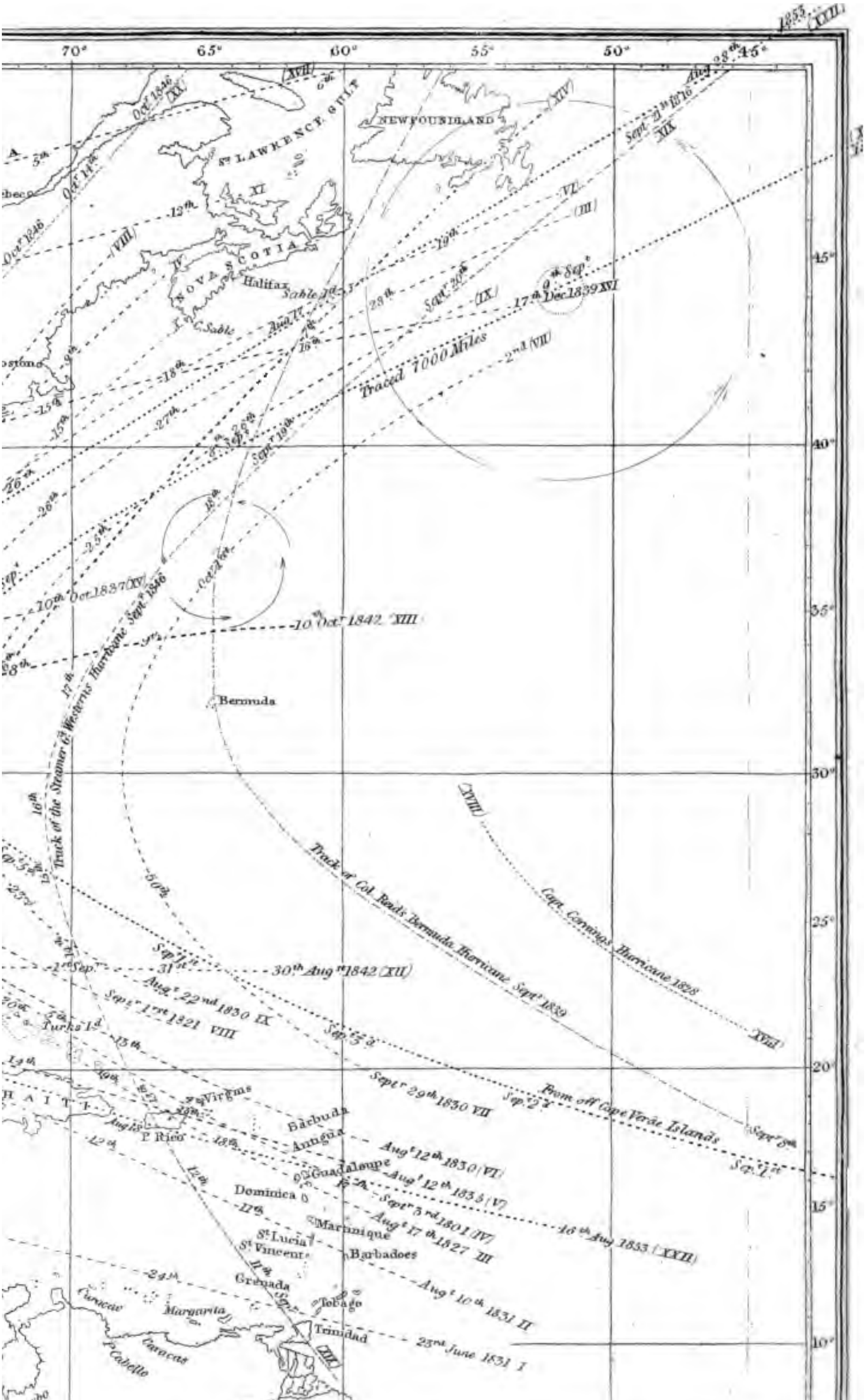
* A "high dawn" is when the first indications of daylight are seen above a bank of clouds. A "low dawn" is when the day breaks on or near the horizon, the first streaks of light being very low down.

† In the tropics, or regions of trade-winds, there is generally an upper or counter current of air, with very light clouds, which is not an indication of any approaching change. In middle latitudes such upper currents are not so frequent (or evident?) except before a change of weather.

‡ Much refraction is a sign of Easterly wind.

‖ Fragments or pieces (as it were) of rainbows (sometimes called "wind-galls") seen on detached clouds.


WESTERN ATLANTIC.
WITH THE COURSES
of Various
HURRICANES,
By
W. C. REDFIELD
1835
with Additions
to 1863
Toronto
Philad
Baltimore
WASHINGTON
Charleston
Natches
Mobile
Pensacola
New Orleans
Galveston
TEXAS
Metamoras
Tampico
MEXICO
Vera Cruz
Havana
Matanzas
FLORIDA
UNITED STATES
YUCATAN
Honduras G
G of Tehuantepec
Volcano of Cosiguina
Mosquito G.
PACIFIC OCEAN
Darien G.
JAMAI
100°
95°
90°
85°
80° W of Green
45°
40°
35°
30°
25°
20°
15°
10°



70°
65°
60°
55°
50°
45°
NEWFOUNDLAND
St. LAWRENCE GULF
NOVA SCOTIA
Halifax
Sable Id.
C. Sable
Boston
Oct. 1846
Oct. 14th
12th
Sept. 20th
17th Dec. 1839 XVI
Traced 7000 Miles
2nd (VII)
Sept. 19th
Sept. 1816
Aug. 28th
10th Oct. 1837 (XV)
Track of the Steamer Great Western's Hurricane Sept. 1846
10th Oct. 1842 XIII
Bermuda
Track of Col. Reid's Bermuda Hurricane Sept. 1839
Capt. Cornings Hurricane 1828
30th Aug. 1842 (XII)
Aug. 22nd 1830 IX
Sept. 1st 1821 VIII
Turks Id.
HAITI
Virgins
P. Rico
Barbuda
Antigua
Guadaloupe
Dominica
Martinique
St. Lucia
St. Vincent
Barbadoes
Grenada
Tobago
Trinidad
Curacao
Margarita
Caracas
P. Cabello
R. Orinoco
Sept. 29th 1830 VII
From off Cape Verde Islands
Aug. 12th 1830 (VI)
Aug. 12th 1835 (V)
Sept. 3rd 1801 (IV)
Aug. 17th 1827 III
16th Aug. 1853 (XXII)
Aug. 10th 1831 II
23rd June 1831 I
40°
35°
30°
25°
20°
15°
10°

DUE MAR 1 '51